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CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

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6 JUL 1962

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT (SECRET): "The Nature of Possibilities of Engineer Preparation of Terrain in Short Periods of Time", by Major-General of Engineer Troops N. Vinogorskiy

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The Nature and Possibilities of Engineer Preparation of Terrain in Short Periods of Time

by

Major-General of Engineer Troops

N. Vinogorskiy

The opinions expressed from time to time concerning the limited possibilities of constructing field engineer structures, blindages, fire trenches (transheya), and communication trenches (khod soobshcheniya) under modern conditions load, in our opinion, to a denial of the need for the provision of antinuclear protection. All increasing technical capabilities for carrying out military-engineer work which are being achieved as the result of the development of equipment and of the increase in the productivity of engineering machinery, are not being taken into consideration here.

We will attempt to substantiate the advisability, nature and methods of achieving the fullest engineer preparation of positions, areas, sectors, defensive lines and areas of troop disposition in a short period of time.

The well-known identical nature of the basic types of engineer structures used by troops in defense, at forced halts during an offensive and while on the march (at lines of deployment, in concentration areas, at troop dispositions for a day's rest, etc) and the frequent replacement of one type of troop combat activity by another, permit one to examine the nature of engineer preparation and the time limits for the fulfilment of work without making a marked differentiation between them according to types of battle and operation.

Thus, we know that during the preparation for an offensive, troops may be located on terrain where a

defensive position had previously been established and may use the structures which were erected there. Transition by troops to the offensive is possible directly from disposition areas or defensive areas.

Under these conditions, the antinuclear protection of the troops, which is equally necessary at all periods of their combat activity, together with the dispersal of units and large units and with their maneuver, presupposes the use of engineer means and methods for the preparation in the shortest possible time of the terrain occupied by the troops. For comparison let us recall that during World War II the time necessary to prepare a battalion's defensive area (batalonnyy rayon oborony - BRO) was 33 to 36 days. In the postwar years this time period was reduced successively to 25, to 20, to 15 and finally, to 10 days. In 1957, according to the experience of exercises carried out in the Moscow Military District, the time necessary for the engineer preparation of a BRO, taking into account the antiatomic protection of personnel was reduced to 5 to 6 days, thanks to fuller utilization of the means of mechanization, and to an expedient decrease in the number and to the simplification of the construction of some types of fortification structures. However, the modern nature of a battle and of an operation demand that engineer preparation of terrain should be carried out in one or two days, and sometimes within several hours on a broad front and in great depth.

In the system of engineer preparation of terrain, the preparation of the siting areas of missile units and the safeguarding of their maneuver acquire special significance. Since this question has already been sufficiently dealt with in the pages of the military press, we will not examine it in the present article.

The problems in the engineer preparation of terrain which have not been resolved to this day are, mainly, those of its fortification and, to a certain degree, those of the use of obstacles.

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Without going into details of the tactical and operational structure of defense, we will simply point out that, in our opinion, the basis of the positions occupied by troops must be the company areas, which have all-around defense, mutual coordination of fire within a battalion area of defense, and which are deployed at intervals, as a rule, along advantageous natural lines. The layout of positions is determined by the combat plan and by the nature of the terrain.

In our opinion, during the engineer preparation of positions and areas one should begin by considering the expediency of using engineer structures of a particular designation, in a quantity which correspond to the availability of forces and means, and the possibility of erecting them, based on the actual conditions at the moment and in the near future. In the latter case, one must keep in mind the means of engineer equipment which it is technically feasible to set up. In our discussions we use the conventional term "full" preparation of areas, which relates to the maximum which it is advisable that we should try to achieve.

Here, we proceed from the requirement that not more than one battalion (or an equivalent installation) should be put out of action by the burst of a small-yield nuclear warhead when an objective is located outside cover and not more than one company (battery or equivalent installation) by the burst of a medium-yield nuclear warhead when troops are under cover.

For our calculation we will take the number of battalions (batalon, divizion) and equivalent objectives in a regiment as being 8 to 10, in a division 50 to 70, and in an army 500 to 700. Let us assume that a platoon strong point occupies an area of 0.25 km^2, a company defensive area one of 1.5 to 3 km^2 and a battalion defensive area from 9 to 15 km^2. Here, the required minimum dispersal will be 100 km^2 for a regiment, 600 km^2 for a division and 6,000 km^2 for an army. Let us note that with areas of these sizes, their entire areas will be more or less evenly occupied

by the troops.

In the areas occupied by troops it is advisable to dig slit trenches (shchel) and trenches (okop) for rifle, artillery and tank subunits, to build blindages and shelters for personnel, to dig dug-out shelters (ukrytiye kotlovannogo tipa) for equipment (for one, two or a maximum of three vehicles) fire trenches and communication trenches (continuous or with breaks); to prepare systems of movement routes (including bridges and crossings), obstacles and water supply; and to carry out the clearing of the terrain, in order to prevent fire, and camouflage measures.

The most labor-consuming measures, which fix the time period for the preparation of positions and areas at 4 to 5 calendar days, are the erection of shelters for personnel and equipment and the excavation of fire trenches, and communication trenches. The contruction of the basic mass types of structures - blindages and shelters built without jointing (bezvrubochnyy) - require large amounts of construction materials (primarily of timber), for the procurement of which much time, labor and transport are necessary. The excavation of dug-outs - shelters for combat equipment and transport vehicles - entails a huge expenditure of manpower or a considerable amount of work with excavating equipment. The execution of these tasks in shorter periods of time is impracticable without the use of improved means of mechanization.

Naturally, with the use of existing engineer equipment and methods for building structures, it is possible to execute in short periods of time, measured in days, only a small volume of engineer works in the preparation of terrain. It is therefore not accidental that, together with the opinion that we should reject the system of fire trenches and communication trenches, which it is supposedly impossible to create with available means, ideas are expressed about the fact that instead of building fire trenches, blindages and shelters, we should limit ourselves to the simplest digging-in - to the digging of

fire trenches, of slit trenches and of a very limited number of shelters for equipment.

It is impossible to agree with these views. The anti-nuclear protection of troops is especially necessary in the period immediately before the start of our offensive, at the moment of the enemy's counterpreparation, and also before his offensive. As we know, shelters and blindages reduce the radius of destruction of personnel by nuclear bursts by two or three times compared with open trenches and fire trenches, and afford protection against radioactive contamination.

Blindages and shelters permit personnel to wait for the radiation level to fall to limits which permit the continuation of actions or the free movement of subunits out of the contaminated zone. Experiments have established the possibility of using blindages, with reliable hermetic sealing, as shelters, with a constant volume of air. In this case, the replacement of used oxygen is achieved by generating it by means of a chemical reaction, in which a substance which is rich in oxygen reacts in a water medium, for example with sodium superoxide (nadperekis natriya). A very small quantity of sodium superoxide is enough to enable personnel to stay in the blindage for at least 3 to 4 hours. Without blindages and shelters, personnel will suffer unnecessary and unjustified losses or will be put out of action for a considerable period of time in such cases.

In our opinion, the listed types of shelters should not be rejected, but it is necessary to investigate the possibilities of erecting shelters and blindages in short periods of time - in 24 hours, or less, with the procurement and delivery of a large amount of timber. They can be replaced by carried, transportable structures which do not require the procurement of materials locally, the erection of which is less labor-consuming and simpler and which, if it is possible, are movable not on special transport but on the same vehicles which move the subunits.

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Therefore, for the erection of blindages and unjointed shelters, and also for the installation of shelters over slit trenches for shells, at artillery positions, approximately 300 to 350 m^3 of timber will be needed for a battalion, 1,500 to 1,600 m^3 for a regiment and 8 to 9 thousand m^3 for a division. To procure this amount of timber, using existing technical means, 200, 800 and 5,000 man-days, respectively, are needed. Taking into account the time needed to organize the work of procurement and to transport the materials, it will be necessary to have the personnel at work for 48 hours. In addition, in many areas, there will be absolutely no possibility of procuring timber.

In a division it will be necessary to make almost 2,000 trips with 4- to 5-ton trucks, for which, depending on the distance between the timber procurement area and the work area, it will be necessary to allot up to 600 or 700 trucks for 24 hours.

Thus, the transition from the existing designs of structures to carried, transportable structures, which troops can erect simultaneously with their occupation of a disposition area, permits the saving of a total of 2 or 3 days, with a corresponding reduction in the time for preparation for a battle or an operation.

Are there real possibilities of making such a change? Yes, from the technical standpoint, this possibility exists. However, it should be noted that the number of sets of fortified structures manufactured by industry and, in a centralized form, by an army and a front at concrete plants, will be strictly limited, and their movement will call for a lot of transport (especially that of the reinforced-concrete structures), and the requirements for the erection of such mass structures as blindages and shelters will not be met. These structures must be erected from the ground up with the use of light equipment which is organic or which is moved on the troop transport. In other words, it is advisable to create special sets of structures for a squad, a crew, a team, a platoon, and a company and for control points. These sets should be small and light in weight

and must permit the erection of the shelters of the means of the subunits themselves.

The requirements indicated are satisfied to a certain degree by existing structures of the KVS type which are built by industry, in particular by the fabric-shell (karkasno-tkanevaya) and fabric (tkanevaya) structures which have appeared lately, and also by structures made with sand bags.

The problem of providing cover for personnel may be simplified even more by using closed, armored personnel carriers, which replace blindages and, in many cases, light shelters as well. These should be located at platoon strong points, close to the squad positions, as a rule on the reverse slopes of rises. Normal excavation machinery can be used to dig the trenches for them if the positions are being prepared in depth. When work is being carried out where there is direct contact with the enemy, it is advisable to bring in tanks with attached bulldozer equipment (BTU) to dig such trenches, and the number of these should be increased to three units per company. In this case, main defensive positions for tanks and armored personnel carriers can be prepared in soils of groups I and II under summer conditions in approximately 3 to 4 hours.

With the existing degree of mechanization in the erection of shelters, the use of mechanized means just to excavate dug-outs underneath blindages (specifically with a fabric covering), which is not at present mechanized, constitutes an economy at divisional level of approximately 4,000 man-days. This will permit a further reduction in the time necessary to prepare the terrain.

Finally, a large reserve for reducing the time taken for engineer preparation is represented by the full and composite mechanization of all engineer work, including that of excavating shelters for equipment, which can only be achieved by increasing the efficiency of engineering machinery.

It can be shown that, in order to carry out the

predetermined volume of work, it is necessary to use about 21 equipment shifts (mashino-smen) in a battalion, 125 in a regiment and up to 1,000 in a division, with the tractor-bulldozers and excavators which are at present with the troops. In order to carry out this work in the course of 24 hours in two 8-hour shifts, it would be necessary to have 12, 78 and 600 machines respectively. Such a quantity of equipment is not in fact at the disposal of the troops.

However, the solution of this task becomes possible with an increase in the efficiency of the machines, which has been achieved in practice by technical improvement of the working elements of the excavating machines (zemleroynaya mashina) which provide the minimum necessary dimensions for dugouts. In the process, the efficiency of the machinery is being increased by 3 to 6 times in the excavation of dugouts, for blindages by 3 to 6 times, for shelters by 7 times, and for equipment by 16 times.

To sum up, thanks to the employment of all the factors listed above, it is possible to shorten the time period for the engineer preparation of zones and areas by 3 to 4 days, as compared with the 4 to 5 days that are taken at present. In a division, in order to carry out all the work in the course of 24 hours, working in two 8-hour shifts, 5 or 6 pieces of equipment (mashina) are needed to make blindages, 18 to make shelters, 5 to make shelters for equipment and, 6 or 7, with increased efficiency, to carry out the other work.

When mechanized apparatus (instrument) and attached equipment are used on tanks and artillery prime movers to excavate dugouts under blindages with fabric coverings and under shelters of fabric-shell construction with ditch-digging machines (kotlovannaya mashina) with an output of up to 500 m^3 an hour, and to excavate dugouts for group shelters for equipment (for 2 or 3 pieces) with machines with an output of up to 1,000 m^3 an hour, and to complete certain tasks of camouflage and fire prevention, a division will have to use approximately 7,000 man-days. This is equivalent to the work output potential of the division

for one day and even leaves a certain reserve.

The preparation of troop disposition areas will be identical with the preparation of defensive areas, which we have examined, except for the excavation of fire trenches and of alternate positions.

Fire trenches and communication trenches have special significance in the system of fortification and preparation of terrain. Incidentally, there are differing opinions on their role, and on the scale of their use in modern conditions.

Naturally, because of the high degree of technical equipment of an army, fire trenches have in many ways lost their former significance as routes of maneuver on a battlefield, retaining it only at squad, platoon and, partially, at company level. A system of fire and communication trenches plays an important role in the concealment of troops, serves as an initial basis for the preparation of terrain, and also provides a minimum of antinuclear protection for the troops when they are changing defensive or disposition areas. In addition, fire and communication trenches act as fire breaks.

It should be noted that there have been no statements completely rejecting fire and communication trenches. Apparently, everyone agrees that fire trenches and communication trenches must exist, to the minimum possible and necessary extent, at a platoon strong point and in a company's defense area. As a rule, the fire trenches will be discontinuous and will be 1.1 m deep, with breastwork up to 0.6 m high. The revetment of slopes is not envisaged and the breastwork is not leveled out or camouflaged.

In examining the organization of defense on open level terrain, let us analyze the scale on which it is advisable to create a system of fire and communication trenches in the largest possible variant.

Squads should have two alternate positions besides a primary fire trench or a sector of a trench about 50 m long.

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This means that the width of the front of a squad's position is about 150 m and the length of the fire trenches, taking into account the coefficient of curvature (izvilistost) (1.3), is about 200 m. In a platoon, the fire trench will also be continuous, with a total length of about 450 to 500 m, and taking curvature into account, it may be up to 650 m long. Between platoon strong points the fire trenches may be discontinuous. However, this will expose each strong point, and therefore the platoon strong points within a company's defense area should, when possible, be connected to one another by fire trenches or communication trenches.

Naturally, a platoon must have at least a small communication trench for communication with the rear, and when two platoon strong points are connected by a fire trench or a communication trench along the front, there should be one communication trench for two platoons. Depending on local conditions these fire trenches may be discontinuous. At points where there are breaks, vertical drapes (maska) are arranged to conceal the passages from the depth. However, the arrangement of these drapes cannot at present be mechanized and requires considerable expenditure of manual labor, so that it is advisable to excavate long communication trenches with trenching machines.

In a company area, in order to establish all-round defense, there can be two fire trenches, running at a distance of 0.8 to 1.2 km from each other.

Bearing in mind that on level terrain the enemy can observe to a depth of not less than 2 to 3 km, it is necessary to dig fire and communication trenches to at least the depth of the battalion defense area. It is advisable to create a single system of fire and communication trenches (continuous or not) in an area which will permit the concealed and varied organization of combat formations. For additional camouflage, dummy structures are erected and scarring of the terrain is carried out with engineer equipment.

At the regimental level, alternate and dummy areas must be prepared. As a result, they fill almost the entire regimental sector. If such a solution is adopted, concealed disposition of a combat formation with a varied and a clustered (ochagovoy) defensive formation, the movement of personnel of all the subunits, the creation of switch (otsechnyy) positions and the all-round defense of battalion areas and of the regimental sector as a whole are ensured.

Since an offensive may begin directly from defensive areas and since, if these are established during the preparation of the offensive, terrain preparation of departure areas is conducted under the guise of organization or improvement of the defense, the scheme we mention may, especially, find a place in the preparation of an offensive also.

In this case, the preparation of a departure area will resemble the preparation of defensive areas, sectors and zones, but will incorporate the development, first of all, of basic positions and of approach routes to the main line of resistance (2 to 4 routes per division) and the organization of passages through enemy obstructions.

Thus, the use of a system of fire and communication trenches, together with scarring of the terrain, practically eliminates the need to carry out a considerable amount of camouflage work in order to conceal individual structures and subunit positions, and makes it possible to carry out a large part of the camouflage work with machinery and organic means of the subunits.

What are the actual capabilities for the excavation of fire and communication trenches? The plow-type trench digger (pluzhnyy transheyekopatel) PTT-60 exists, together with the fast trenching machine (bystrokhodnaya transheynaya mashina - BTM), and is capable of digging a trench up to 60 cm deep and has a high output - in favorable conditions 1.5 to 2 km of trenches per hour, or more.

Since the motorized rifle subunits in a regiment, located at their basic positions, occupy approximately 4 km of fire and communication trenches (about 2 percent

of the total length) the latter can be excavated with a BTM in one day, working in two 8-hour shifts. With an equipment productivity coefficient of 0.5 (time lost in the frequent beginning and completion of digging by the working element and in its movements), two BTM will be required to carry out the work. For a regiment this is quite realistic. In a regiment, in order to carry out the remaining trenching, with a trench continuity coefficient of 0.3, four PLT-60's will be required, - three, if the number of trenches is decreased from 8 to 6.

Since the trench excavated by a PLT-60 has a profile which does not completely suffice for troops, it is advisable to replace it with a machine with a higher output, excavating up to 3 km of trenches an hour with a depth of 1.1m (i.e., with a time norm of up to 0.035 equipment - shifts/km^2). The construction of such a machine is completely feasible in practice. Then only 2 or 3 machines will be required to carry out all the work in a regiment within one day, organized in two 8 hour shifts, and using a second shift by operators (coefficient of replacement 1.5) with a trench continuity coefficient of 0.5.

In the conditions examined, 8 to 10 machines are sufficient for a division (5 machines can be in the TO&E of the division and 3 to 5 can be attached by reinforcing the division with an engineer-siting company).

Naturally, if the troops do not take cover in them, the positions and fire and communication trenches which are being or have been prepared in concentration and disposition areas, or in the separate sectors of these, will be of limited importance, but they will still be necessary here, too, especially when units and subunits are being deployed in woods in order to decrease losses from indirect destruction during nuclear bursts.

The preparation of terrain where there is direct contact with the enemy, especially in the area of the first and second fire trenches, where the use of trenching machines is ruled out, is carried out with the aid of a

developed and improved mechanized tool which increases the efficiency of trench digging by two or three times.

Let us list some ideas on the organization of work in a period not exceeding 24 hours. Two or three hours will be needed from the moment when an order is received for the preparation and organization of the work; the machines should work two shifts - a total of 16 hours - and two hours will be needed to complete the work. A total of 20 to 21 hours will be used. Personnel, divided into two shifts, will work approximately 10 hours during this period.

It can be assumed that during the first shift (within 10 to 11 hours, including the time for organizing the work) approximately 50% of all the structures will be made ready. The remainder can be completed during the remaining 10 hours of work.

Some words, now, on the sequence of the engineer preparation of positions, in connection with the organization of the work. Under modern conditions the sequence of work, when there are short periods of time for the preparation of operations, is determined on the basis of the requirement that the troops should be constantly ready for the forthcoming operations. These, if one may call them this, are the tactical requirements in the sequence of carrying out the work - a gradual increase in the preparedness of positions through a successive progression from the simplest types of structures, giving a minimum of antinuclear protection, to more complex structures which provide a high degree of protection. In practice, it runs as follows: first the personnel dig the simplest shelters, which at the same time permit the delivery of fire, foxholes for firing from kneeling and standing positions; then covered slit trenches and trenches at their basic positions; then alternate positions and fire trenches connected to the main trenches by fire trenches can be prepared, communication trenches and blindages for the personnel are dug and partial cover for equipment may be prepared; later, shelters are erected involving the conversion of some blindages, and

all the other work is completed.

Is this sequence of work always advisable? It can only be justified in one case: when the chiefs organizing the work do not possess exact data on the possible approach of the enemy and on the joining of battle. During the preparation of rear lines and of defensive areas in the rear, where the subunits carrying out the work have sufficient time and can use machinery, it is advisable to begin to carry out the entire volume of work which has been planned at once. In practice, the rational organization of work and its sequence is most often somewhere between the two cases given above - usually both types of requirements are rationally interrelated; in the beginning one must be guided by technical requirements, and later by tactical ones.

Thus, with the increase in the volume of fortification work and the decrease in the time allotted for its fulfilment, existing engineer equipment only permits partial accomplishment of this task. In order to prepare the areas occupied by the troops, with the provision of a high degree of antinuclear protection, new means of engineer equipment are needed. Technically, the production of such means has already been resolved, and with their presence with the troops real opportunities will appear for the carrying out, in 18 to 24 hours, of engineer preparation of terrain in a defense zone, in the departure areas for an offensive and in other areas occupied by the troops, deployed in a system of intermittent fire and communication trenches or not, in a system of zones and lines or outside them.

Here, with the introduction as equipment of a definite number of high-output machines, of structures and obstacles which are of sufficiently durable, easily assembled and transportable construction, and with the use of armored personnel carriers as shelters, the complete and actual capability to prepare terrain within 24 hours will exist. During this period, obstructions can be set up and blindages and shelters of the fabric-shell type and with fabric

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overhead covering can be constructed, structures can be partially erected at control points using other types of structures : manufactured by industry, and of local materials.

In passing, it should be pointed out that the freeing from mines, the refitting, and the use during an operation of structures captured from the enemy are of no small importance in the engineer preparation of terrain.

The short periods of time available for carrying out engineer work also impose demands on the preparation of a road network and of bridges to support maneuver. However, the volume of these tasks, as compared to those of fortification as a whole, is much smaller, especially in theaters of military operations (teatr voyennykh deystviy-TVD) which have developed networks of roads. In the Western TVD, where the density of the road network reaches 1 km of road per square kilometer, the requirements of the troops for movement routes in the defensive areas and in any other areas of troop disposition are almost completely satisfied. Engineer support for the maneuver and movement of troops is no longer a problem. Several hours are spent in checking whether the routes in the zone of a division are mined, with the help of existing means for reconnaissance and mine-sweeping (flails [tral], road induction mine detectors and others). These engineer support tasks limit combat and operational preparation to a lesser degree, except, of course, in certain special situations (slush, for example, or swampy terrain) .

Engineer preparation of terrain includes the setting-up of obstacles. Because of the clustered nature of the defense, a system of obstacles must be created not only in front of the basic defense areas but also in the gaps between them. The system of obstacles, the method for using these and their arrangement depend on the probable nature of enemy operations and on the terrain. The larger part of the means will, as before, establish itself during the battle along the most important axis.

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Of the particular questions concerning a system of obstacles, we will dwell on the following. In order to counteract reconnaissance, and to discover and help to capture enemy reconnaissance personnel (razvedchik), large-scale use can be made of signaling devices, installed along a broad front, in front of the areas occupied by the troops, by the forces and means of the subunits of these troops, and, in the gaps, by engineer units, to support the subunits carrying on observation.

The use of antipersonnel mine barriers in the depth and in fortification obstacles is unlikely, in our opinion, under modern conditions.

Antitank mine barriers will be used on a larger scale, installed both in front of the forward edge and in the depth of the defense.

While there is direct contact with the enemy, the use of mechanized means, including helicopters, for the laying of minefields is practically excluded. Here, mines must be laid by hand. However, with the existing types of antitank mines, this requires a lot of time and personnel. It is therefore advisable that, together with the regular types of obstacles, mines with a wide front of action (mina shirokogo fronta deystviya) (25 to 30 linear meters per mine) should be used; even if these are installed manually, little time is used (up to 2 or 3 man-days per km) and they are simple, safe to handle and, if necessary, controlled (upravlyayemyy).

In front of the areas occupied by troops in the depth, it is advisable to lay antitank mines with mine-layers during combat. Advance laying of mines in front of these areas is not, as a rule, advisable.

The most acceptable types of obstacles in the gaps in an operational formation, or in troop combat formations, may be those installed along detected axes of enemy movement during the course of or before combat; the mass use of mines and the destruction of routes on the most important

axes; and the establishment of zones of obstacles and of zones of destruction, installed partially in advance but mainly during combat, by engineer units, in coordination with the troops which have received the task of inflicting counterattacks and a counterstrike against an enemy who has broken through. It seems that such zones will be combined with the areas of fire destruction of the enemy by the means of artillery and nuclear/missile units, and the system of obstacles must be linked with these areas.

A system of operational obstacles is set up in the depth of the defense, to assist the operation of the forces of the army and front. These obstacles may be set up on the basis of existing norms along axes or lines and in areas as obstacles along roads, or as separate zones or centers of obstacles along water, mountain and other natural lines. The installation of a system of obstacles of this type presupposes the wide use of mechanized equipment.

In view of the very extensive possibilities of a landing by airborne forces and of the practically unlimited and undetermined size and area of such a landing, it should be recognized that the advance establishment in terrain of obstacles to the landing of airborne forces is not advisable.

As a whole, the volume of work on obstacles in defense is growing, and this calls for an increase in the number of engineer forces and means, including helicopters, brought in for this work. In modern conditions, special significance is acquired by maneuverability in the use of obstacles during a battle and in an operation, by the role of the reserves of the engineer forces and means, and by the participation of subunits and units of arms of troops in the installation of obstacles.