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CENTRAL INTELLIGENCE AGENCY
WASHINGTON 25, D. C.

4 JUN 1962

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MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT (TOP SECRET): "Some Problems in Destroying Targets with Nuclear Warheads", by Chief Marshal of Artillery S. Varentsov

1. Enclosed is a verbatim translation of an article which appeared in the TOP SECRET Special Collection of Articles of the Journal "Military Thought" ("Voyennaya Mysl") published by the Ministry of Defense, USSR, and distributed down to the level of Army Commander.

2. For convenience of reference by USIB agencies, the codeword IRONBARK has been assigned to this series of TOP SECRET CSDB reports containing documentary Soviet material. The word IRONBARK is classified CONFIDENTIAL and is to be used only among persons authorized to read and handle this material.

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Richard Helms
Deputy Director (Plans)

Enclosure

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Original: The Director of Central Intelligence

cc: The Director of Intelligence and Research, Department of State

The Director, Defense Intelligence Agency

The Director for Intelligence, The Joint Staff

The Assistant Chief of Staff for Intelligence, Department of the Army

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COUNTRY : USSR

SUBJECT : MILITARY THOUGHT (TOP SECRET): "Some Problems in Destroying Targets with Nuclear Warheads", by Chief Marshal of Artillery S. Varentsov

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Following is a verbatim translation of an article entitled "Some Problems in Destroying Targets with Nuclear Warheads", by Chief Marshal of Artillery S. Varentsov.

This article appeared in the 1961 Fourth Issue of a special version of the Soviet military journal Voyennaya Mysl (Military Thought). This journal is published irregularly and is classified TOP SECRET by the Soviets. The 1961 Fourth Issue went to press on 20 October 1961.

Headquarters Comment: "Military Thought" is published by the USSR Ministry of Defense in three versions, classified RESTRICTED, SECRET, and TOP SECRET. The RESTRICTED version is issued monthly and has existed since 1937. The SECRET version is issued irregularly. By the end of 1961, 61 issues had been published, 6 of them during 1961. The TOP SECRET version was initiated in early 1960 and is also issued irregularly.

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Some Problems in Destroying Targets with Nuclear Warheads

by Chief Marshal of Artillery S. Varentsov

As is known, the use of nuclear weapons is making fundamental changes in the quality of fire and is increasing immeasurably the force of fire strikes against the enemy. The effectiveness of the destructive power of nuclear weapons can be judged by the fact that it is sufficient to deliver only two or three nuclear strikes with a yield of 300 kt each to destroy an infantry or armored division located in the concentration area.

The destructive effect of a nuclear weapon is greatly increased through the use of surface nuclear bursts, which result in an additional destruction of enemy personnel by strong radioactive contamination of the terrain following the drift of the cloud formed by the burst. Thus, with a surface nuclear burst with a yield of 300 kt and with a wind speed of 20 kph, the burst itself will destroy unprotected personnel in an area of 30 km^2. Because of the radioactive contamination of the terrain, however, one hour after the burst the unprotected personnel in an area of 80 km^2 will receive a dose of radiation of 200 roentgens. Thus, the total area of destruction increases from 30 to 110 km^2.

The significant radioactive contamination of terrain created by surface bursts and by a wind favorable to us permits a paralysis of enemy maneuver over a large area. But, if careful consideration is not given to the force and direction of the wind, then one can contaminate one's own troops or lower their maneuverability with one's own nuclear strikes. This consideration must be kept in mind when planning surface nuclear strikes.

The use of missiles as delivery vehicles for nuclear charges has increased immeasurably the depth of the effect of fire on the enemy. There cannot be a single enemy objective which can remain inaccessible to our nuclear strikes.

The great range of fire of missiles makes it possible to resolve the problem of fire maneuverability in a new

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CSDB-3/650,234

and more successful way than formerly while conducting an operation. It is now possible to maneuver fire on a sufficiently broad scale and, thereby, quite effectively and quickly influence the course and outcome of combat operations. By using missile units and large units of front and army subordination to carry it out, maneuver by fire is possible along the entire offensive zone of a front and an army. Furthermore, missile large units and units may be used successfully to carry out missile/nuclear strikes not only in their zone but also in the zones of adjacent armies.

All the above-mentioned qualities of missile/nuclear weapons allow them to be used for primary missions of destroying the enemy and, first of all, for missions of destroying the enemy's means of nuclear attack, his aircraft on his airfields, his missile and nuclear warhead depots, his control points, his first echelon troops and his operational reserves in concentration areas, and in unloading and other areas, as well as his most important objectives of the rear.

If a count is made of the number of objectives in the offensive zone of a front, the destruction of which can be assigned to nuclear weapons, it would reveal that they greatly exceed the possible allotment of nuclear warheads for the operation. Table 1 shows the most typical objectives of an enemy field army, the destruction of which objectives can be assigned to nuclear arms.

In order to insure success in an offensive operation, when only a limited amount of nuclear warheads is available, it is necessary to exercise great care in selecting the objectives to be destroyed by nuclear weapons. They must truly be the most important objectives, the destruction of which will result in achieving fire superiority over the enemy, a sharp change in the relative strength of forces in our favor, the loss of control by the enemy, and, as a result, the creation of most favorable conditions for operations by tank, motorized infantry and airborne large units and units in completing the total rout of the enemy. The first to be destroyed are the enemy's means of nuclear attack, his main grouping, including those troops occupying defensive positions in the tactical zone, his most important operational reserves, and his large control points.

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The experience of command-staff exercises and of exercises with troops shows that the staffs, when planning missile/nuclear strikes, often fail to take into consideration the nature of targets and the fire capabilities of missile units and large units. The yields of nuclear charges needed for the destruction of specific targets are estimated by eye (na glazok), without taking into account the actual characteristics of the missiles or the nature of the targets. Estimates of the expected result from each missile/nuclear strike and of the possible enemy losses suffered from a massed strike are not made. All this produces a wasteful expenditure of powerful means of destruction and, as a result, considerably reduces the fire effect upon the enemy.

When planning missile/nuclear strikes, the combined-arms staffs and the staffs of missile troops and artillery of a front or army and, in a number of cases, of a corps and division, besides selecting objectives for destruction, designating a missile unit or large unit to carry out each fire mission, and resolving many other problems, also have to select the yield of a nuclear charge needed for the destruction of each target and estimate the expected result of fire against each target by charges of a given yield.

The destruction of each of the targets shown in Table 1 calls for a nuclear charge of a definite yield. The latter depends on the nature and size of the target, the accuracy in preparation of fire, the effect of the nuclear charge at the target, and the assumed value of the index of fire effectiveness.

Accuracy in preparation of fire is the result of the total effect of technical dispersion of a given type of missile and of errors in the preparation of fire data. It is defined as a mean error determined from tables of fire or with the help of tables prepared in advance.

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Table 1

The Most Typical Objectives for Destruction by Nuclear Weapons

Name of objective	Element of objective to be destroyed	Distance from forward edge, in km	Area of objective, in sq km	Approximate number in field army zone
Missile means of nuclear attack	Materiel	50-150	-	35 (92)*
Batteries of 203.2mm howitzers and 280mm guns	Personnel in trenches	4-10	-	51
Infantry and tank companies of the first echelon of divisions	same as above	-	3	85
Battle groups and tank battalions of the second echelon of divisions	Personnel in trenches and tanks	10-30	12-25	19
Infantry divisions of second echelon of army corps (AK) and field army (PA) in areas of concentration	Exposed personnel	60-200	300	3

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CSDB-3/650,234

Name of objective	Element of objective to be destroyed	Distance from forward edge, in km	Area of objective, in sq km	Approximate number in field army zone
Armored divisions of second echelon of AK and PA in areas of concentration	same as above	60-200	400	3
Tank battal-ions of Reserve of the High Command (RGK) in areas of concentration	same as above	25-70	12	4
Command posts of infantry divisions (PD), AK, PA, and army group	Vehicles in shelters	8-170	3-20	17
Field air-fields of tactical aviation (TVA) and company airfields of army aviation	Aircraft	20-400	1-35	32
Control and warning centers and control centers for aviation in the sector	Radar in shelters	30-300	1-2	4

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CSDB-3/650,234

Name of objective	Element of objective to be destroyed	Distance from forward edge, in km	Area of objective, in sq km	Approximate number in zone
Army supply depots, nuclear warhead supply points, and special weapons depots of the forward area.	Light type of blind-ages	30-250	4-25	13
"Nike" and "Hawk" SAM batteries	Materiel	10 and more	-	72

*Shown in parentheses is number of launching mounts.

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The effect of a nuclear burst at the target depends on the yield of the nuclear charge, the type of burst (air or surface), and the degree of target protection. The radius of the zone of destruction serves as the characteristic of the effect of a nuclear burst.

Numerical characteristics of probability are called indices of fire effectiveness and are used to help estimate the possible results of fire. In carrying out a nuclear strike against enemy means of nuclear attack, or against other small-sized targets, the result of the firing can be either full destruction (annihilation) or non-destruction of the target. Consequently, a probability of destruction of the target may be assumed, and is assumed, to be the index of fire effectiveness.

In firing on collective targets (infantry company, battle group, command post, etc) which occupy comparatively large areas, the results of fire may vary in each individual case. In some cases the target may be annihilated completely, and in other cases only partially destroyed, in which event its combat effectiveness may be lost completely, partially, or not at all. And, finally, the target may not be destroyed at all. Because of this, fire effectiveness against collective targets is estimated not on the basis of probability of destruction of the target, but on the basis of the size of its smallest part to be destroyed with a prescribed probability. In planning fire for annihilation, the size of the smallest part of the target must be such that as a result of its destruction the entire target loses its combat effectiveness.

Used as supplementary indices of fire effectiveness against collective targets are the mathematical expectancy of the relative value (percentage) of the destroyed part of the target and the largest possible percentage of the destroyed part of the target.

The location, nature, and size of the target are usually determined as a result of reconnaissance, but the distribution of individual elements within the target area is usually not known. Therefore, in computing indices of fire effectiveness, it is assumed that individual elements

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of the target are evenly distributed over its entire area. Consequently, instead of determining the size of the smallest part of the target, the size of the smallest part of the target area covered by the zone of burst of a nuclear charge with a given probability is determined. It is considered that the percentage of the target area covered by a nuclear burst zone equals the percentage of the destroyed part of the target's elements.

When selecting the yield of a nuclear charge for a single missile launching, as well as when determining the expenditure of missiles for the destruction of targets if the yield of one available charge proves to be insufficient, it is necessary to know the value of the fire effectiveness index. The values of indices cannot be established on the basis of theoretical considerations alone. Their selection is based on combat operational experience and on various economic, production, and technical considerations. The accumulation of combat experience and the consideration of changes in enemy troops' morale, arms, tactics, and technical equipment, and in production and economic capabilities, bring about changes in fire effectiveness requirements.

At the present time, when selecting yields of nuclear charges, the probability of destruction of enemy means of nuclear attack and of other small-sized targets is assumed to be 90 percent. This means that, when firing against such targets with charges of a selected yield, in 90 cases out of 100 they will be annihilated, while in the other 10 they will not be destroyed.

When selecting yields of nuclear charges for the annihilation of collective targets, the minimum size of target area which, when destroyed, constitutes the destruction of the entire target, is 40 percent. Thus, the probability of destruction of at least 40 percent of the target area is assumed to be equal to 90 percent. This means that, when firing charges of a selected yield on collective targets, in 90 cases out of 100, 40 percent or more of the target area will be annihilated, while in the other 10 cases less then 40 percent of the target area will be destroyed. In the future the minimum part of the target area with 90 percent destruction probability will be called the reliably destroyed area (nadezhno porazhayemaya ploshchad) and will be designated S_o.

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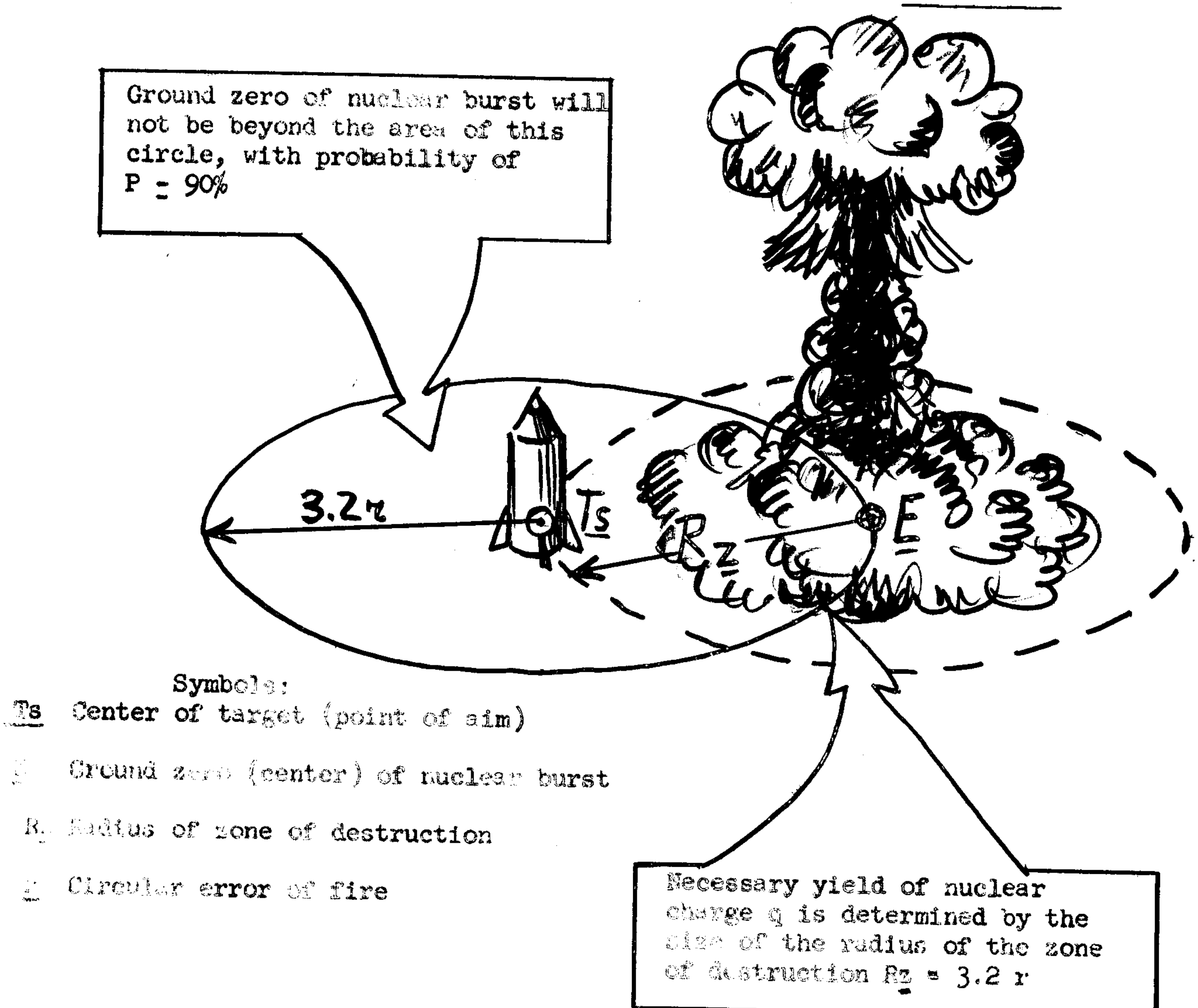
The physical basis for the rules of selecting the necessary yield of a nuclear charge for the destruction of small-sized targets is shown in Sketch 1, and of collective targets in Sketch 2.

Sketch 1



Sketch 1. Yield of nuclear charge necessary for the destruction of an individual target.

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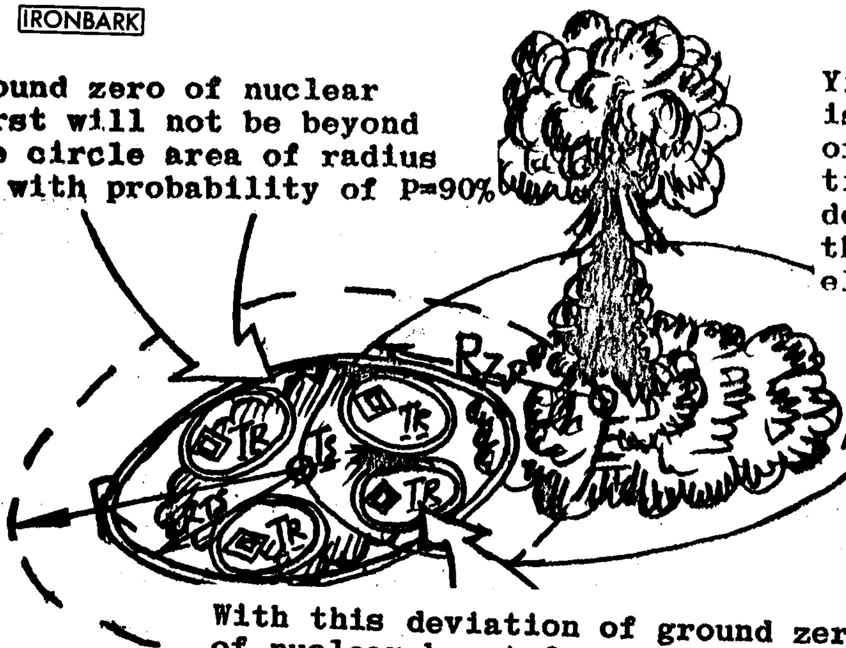
CSDB-3/650,234

Ground zero of nuclear burst will not be beyond the circle area of radius R, with probability of P=90%

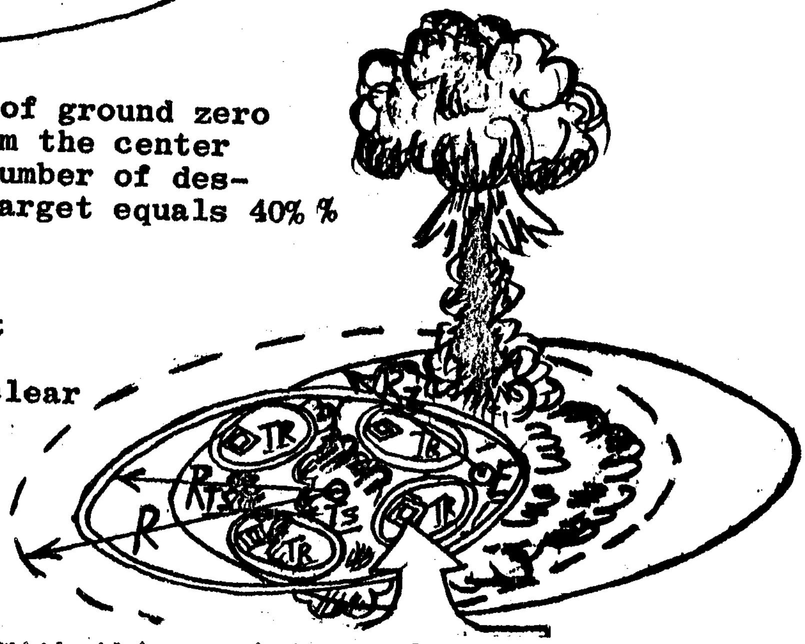
Yield of nuclear charge q is determined by the size of the radius of destruction zone R, assuring the destruction of not less than 40% of the target elements



With this deviation of ground zero of nuclear burst from the center of the target, the number of destroyed elements of target equals 40% %

Symbols:

- **Ts** Center of collective target (point of aim)
- **E** Ground zero (center) of nuclear burst
- **Rts** Radius of target
- **Rz** Radius of the zone of destruction



With this deviation of ground zero of nuclear burst from center of target, the number of destroyed elements of target is over 40%

Sketch 2. Nuclear charge yield necessary for the destruction of a collective target. /TR = tank company/

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When selecting the necessary yield of a nuclear charge, it is necessary, first of all, to determine the radius of the nuclear burst zone, R_z, which will assure coverage by the burst zone of the entire small-sized target, or 40 percent of the area of a collective target. For this, a circumference is drawn, using the aiming point (center of the target) as its center, with a radius, R, that would assure 90 percent probability of hitting within its circle in firing a given missile at a given range (Sketches 1 and 2).

The radius of a nuclear burst zone, R_z, which will assure the destruction of a small-sized target is assumed to be equal to the radius of the drawn circle (Sketch 1).

When determining the radius of a zone, R_z, which will assure the destruction of a collective target, a point on the circumference of radius R (Sketch 2) is selected as the center of a circle with a radius that would have the circle over 40 percent of the collective target.

Using the calculated radius of the zone R_z, it is possible, with the help of special reference books, to determine the yield of nuclear charge necessary for the destruction of a given target, depending on the nature and degree of cover of the target and on the type of nuclear burst (air or surface).

In practice, the yields of nuclear charges necessary for the destruction of given targets are determined with the help of previously prepared charts or tables. Charts P-1, found in the Information Collection of the Artillery No. 50, may serve as samples of such charts. The tables are found in the Manual of Firing and Fire Control of Operational-Tactical Missiles.

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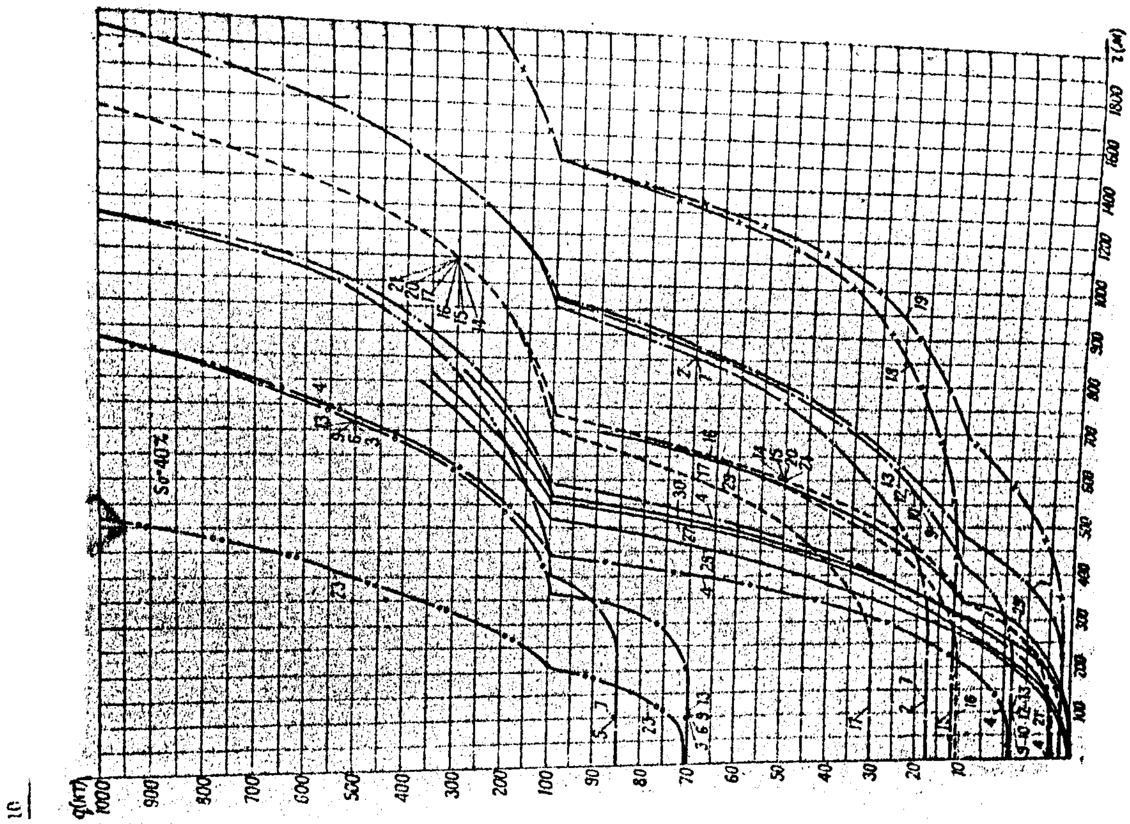
CSDB-3/650,234



Sketch 3. Chart of the Relationship of the Required Nuclear Charge Yields to Firing Errors and the Nature of the Target.

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Sketch 3, which was prepared for the typical targets listed in Table 1 and which is based on the average sizes of these targets, shows the relationship of the necessary yield of a nuclear charge, q, to the nature and size of the target and the characteristics of firing errors, when using the above-indicated values of indices of fire effectiveness.

With the help of this chart, on the basis of a known value of the characteristics of errors in fire preparation, r, of a given type of missile, it is not difficult to determine the yield of a nuclear charge of a given type of missile necessary to annihilate the target.

Example 1.
Determine the yield of nuclear charge, q, necessary for the destruction of a mount of a "Redstone" guided missile with an air burst, when firing a missile, whose average error in fire preparation is 540 m.

On the chart in Sketch 3, a perpendicular line is drawn from point r = 540 m to where it intersects Line No. 28, which represents the launching mounts for the "Corporal" and "Redstone" guided missiles. The reading on the vertical axis opposite the point of intersection is q = 120 kt.

The above answer means that, when firing a missile with a mean firing preparation error of 540 m and a nuclear charge with a yield, q = 120 kt, a "Redstone" guided missile mount will be destroyed with a probability of 90 percent.

Example 2.
With the same conditions as in Example 1, determine the yield of nuclear charge necessary to annihilate a battle group in a concentration area.

On the same chart draw a perpendicular from point r = 540 to where it crosses Line No. 7, which represents a battle group in a concentration area. The reading on the vertical axis opposite the point of intersection is q = 27 kt.

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CSDB-3/650,234

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The above answer means that under the specified conditions a nuclear charge with a yield of q = 27 kt will annihilate not less than 40 percent of the target area with a probability of 90 percent.

A study of the chart showing the relationship of the necessary yield of a nuclear charge q to the nature of the target and the characteristics of firing errors allows the following conclusions to be drawn.

1. With an increase in the errors of fire preparation, r, there is an increase in the yields of nuclear charge necessary to destroy the target. For example, to annihilate a "Corporal" or "Redstone" guided missile launching mount with a missile, when the mean error of fire preparation is r = 100 m, a nuclear charge of approximately 2 kt is required, and, when r = 500 m, a charge of approximately 90 kt yield is required.

2. When firing missiles which have a mean fire preparation error of 0 to 300 m, the nuclear charge yield, q, necessary to annihilate a collective target depends on the nature and size of target and does not depend, or depends only to a small degree, on the characteristics of firing errors. For example, to annihilate a battle group in a concentration area (Line No. 7 of the graph in Sketch 3) with a missile, when the mean fire preparation error is r = 0, the required yield of nuclear charge is q = 18 kt. To annihilate the same target, but with a missile with a mean error of fire preparation of r = 300 m, a nuclear charge of the same yield, q = 18 kt, is required.

It follows that, based on the requirements for the destruction of collective targets, in creating new missiles, primarily those of an operational-tactical designation, the accuracy of fire preparation may be within the limits of 200-300 m.

However, in the course of combat there will be instances when the distance between small units of our own troops and the counterattacking (attacking) sub-units of the enemy, or the enemy's line of resistance, will be 1.5 to 2 km. In these instances, the nuclear charge yield and the mean fire preparation error must be minimal in order to insure a safe distance of 1.5 to 2 km for our own troops. Figures show that this requirement

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is met by missiles with a mean fire preparation error of not more than 100 m and with a nuclear charge yield of 1 to 2 kt. The aforementioned missiles will allow the annihilation to the required degree of destruction, of such most typically close combat targets as an infantry company on the offensive or on the defensive. These same missiles will assure the destruction of enemy tactical means of nuclear attack and certain other targets shown in Table 1.

3. It is evident from the chart (Sketch 3) that when there are large fire preparation errors, the nuclear charge yield necessary for the annihilation of a collective target depends to a large degree on the nature of the target and fire errors, and not on the size of the target. For example, with a mean fire preparation error of r = 1000 m, the same nuclear charge yield, q = 120 kt, is required for the annihilation of an infantry company on the offensive in an area of 1 sq km or of a battle group on the offensive in an area of 20 sq km (these targets are represented on the chart by Lines No. 1 and 2). To annihilate these same targets when they are on the defensive, and when the personnel are protected in trenches (these targets are represented on the chart by Lines No. 4 and 5), a nuclear charge with a yield of 500 to 550 kt is required.

It is evident from the examples cited above that missiles which have large errors in fire preparation and which have a maximum range of over 500 km must be armed with charges of large yields (from 100 to 600 kt) and be used for the annihilation of large collective targets. It is inadvisable to use such missiles and charges in firing on small-sized collective targets, because the employment of large yields of nuclear charges against such targets would be wasteful.

The chart in Sketch 3 may be used directly when planning nuclear strikes against various targets. Also, with the help of this chart, it is possible to prepare, in advance, tables of the yields of nuclear charges necessary for the destruction of various targets by a single firing of a missile of a given type.

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It is evident from the chart (Sketch 3) that the annihilation of the targets shown in Table 1 with the assumed degree of destruction requires nuclear charges of yields from 1 to 500 kt and higher. In practice, each type of missile has a small choice of nuclear charge yields with which all the missions for this missile must be fulfilled. For example, the missile R-170 has nuclear charges with yields of 10, 20, and 40 kt. Therefore, when planning missile/nuclear strikes and determining the necessary yield of the charge, one also has to determine the expected degree of destruction when firing on the target with a charge of a given yield, i.e., to find out what the value of the fire effectiveness index will be, if a given target is hit with a nuclear strike with a yield which is different from one selected in accordance with the chart (Sketch 3).

At the present time, this very important problem is solved with the help of previously prepared charts, such as the ones found in the Information Collection of the Artillery No. 50. These charts permit, with realistically acceptable accuracy, the determination of the expected degree of destruction for any nuclear charge yield.

As previously stated, tactical and operational/tactical missiles have a comparatively small choice of nuclear charge yields; this makes it possible to draw up in advance for each yield quite simple charts of the relationship of the degree of destruction (the probability, P, of destruction of a small-sized target or of the reliably destroyed area, S_o, of a collective target) to the nature of the target and fire preparation errors.

Sketch 4 shows an example of such a chart drawn for a nuclear charge with a yield of 40 kt and for the targets listed in Table 1.

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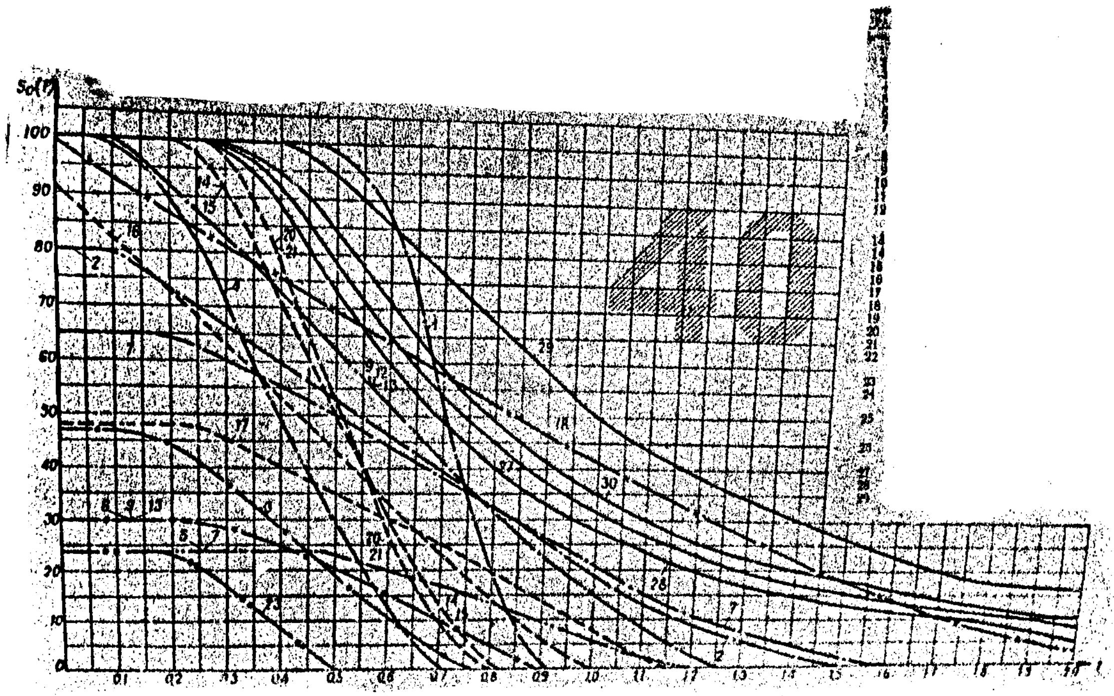

Sketch 4. Chart of the Relationship of the Degree of Target Destruction to the Nature of the Target and Firing Errors

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Sketch 4. Chart of the Relationship of the Degree of Target Destruction to the Nature of the Target and Firing Errors

№	Nature of Target
1.	Infantry company of the first echelon on the offensive
2.	Battle group of the second echelon on the offensive
3.	Tank battalion on the offensive
4.	An infantry company and a tank company on the defensive
5.	Battle group of the second echelon on the defensive
6.	Tank battalion on the defensive
7.	Battle group of an infantry division (PD) of the second echelon in a concentration area
8.	Infantry division in a concentration area
9.	Tank battalion in a concentration area
10.	Motorized infantry battalion in a concentration area
11.	Armored division in a concentration area
12.	Field artillery battalion in a concentration area
13.	Tank battalion of the Reserve of the High Command (RGK), in a concentration area
14.	Division command post.
15.	Army corps command post
16.	Field army command post
17.	Army group command post
18.	Field airfield of tactical aviation
19.	Airfield of army aviation
20.	Control and warning center
21.	Sector aviation control center
22.	Army nuclear warhead supply point
23.	Tank battalion column
24.	Column of a battle group and a battalion of "Corporal" guided missiles
25.	Column of battalions of "Honest John" free rockets and "Lacrosse" guided missiles
26.	Launching site for "Honest John", "Lacrosse", "Hawk", "Nike"
27.	Launching site for "Corporal", "Redstone"
28.	Launching site for "Matador", "Mace"
29.	280 mm and 203.2 mm battery

________ Means of nuclear attack
- - - - Command posts
-x-x Aircraft on airfields
-o—o— Crews in tanks
—.—.— Exposed personnel
—..—..— Personnel in trenches
—oo—oo— Personnel in light shelters

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Besides the expected degree of destruction, such a chart also reveals the largest possible percentage of the destroyed portion of a collective target. The expected degree of destruction is determined in a way similar to that of determining the necessary nuclear charge yield from the chart in Sketch 3. In order to arrive at the maximum possible percentage of the destroyed part of a collective target, r is assumed to be equal to 0, and the rest is done in the same manner as when determining the expected degree of destruction.

Example 3.

Determine the reliably destroyed area and the highest possible percentage of the destroyed part of a battle group in a concentration area, if it is planned to fire a missile with a nuclear charge of 40 kt yield and with a mean fire preparation error of r = 600 m.

On the chart in Sketch 4, a perpendicular line is drawn from point r = 600 m to where it intersects with Line No. 7, which represents a battle group in a concentration area. The reading on the vertical axis opposite the point of intersection is S_o = 44 percent. The reading at the point of intersection of Line No. 7 with the vertical axis (r = 0) is S_o = 65 percent.

The result obtained indicates that, when firing under specified conditions, in 99 cases out of 100 the destruction of the target area will be 44 to 65 percent. In the other 10 cases the destruction will be less than 44 percent of the target.

It may happen in practice that, in order to achieve destruction of a given target, a nuclear charge of a certain yield is required but that the only charges available are those of a different yield. If the yield of the charge is greater than is required, the reliability of destruction of a given target will be greater. Example 2 shows that in order to destroy a battle group in a concentration area, a nuclear charge of q = 27 kt is required. It is not difficult to determine from the chart in Sketch 4 that if the same target, under the same conditions, is hit with a nuclear charge of 40 kt yield, the reliably destroyed part of the target area will be 48 percent instead of 40 percent.

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If the yield of an available nuclear charge is smaller than that necessary for the destruction of a given target, several nuclear charges may be used in order to fulfil the fire mission with the required reliability. The number of nuclear charges equivalent to one charge of a required yield may be determined from tables usually found in the manuals for firing and fire control of tactical and operational-tactical missiles.

It should be noted that if there is no tactical necessity for a simultaneous strike by all the missiles assigned to a given target, it is advisable to deliver the strikes successively. However, each successive strike is to be made only if the previous one failed to destroy the target.

Very often a target, especially such as the means of nuclear attack, will be destroyed by the initial firing with a nuclear charge of a small yield. Thus, Example 1 shows that the nuclear charge needed to destroy a "Corporal" guided missile mount must be 120 kt. If, under the same conditions, a strike is made with a charge of 40 kt, then, as is evident from the chart in Sketch 4, the probability of destruction of this target with the first strike will be 67 percent. This means that in 67 cases out of 100 the target will be destroyed by the very first shot. A second shot will be necessary only in 33 cases out of 100.

In conclusion, we wish to note that the above-mentioned problems of evaluation of fire effectiveness, although basically simple, are labor-consuming and take up much of the time and energy of generals and staff officers. Electronic computers capable of rapidly solving not only such problems as were mentioned here, but many other problems dealing with troop and fire control, are being developed at the present time and will be issued to the troops as they become available.

[redacted]