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Military Thought [redacted] Organization for the Detection, Reconnaissance and Engagement of Air Targets at Low Altitudes

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Summary

This article summarizes the results of an exercise held in September 1967. The exercise employed ground observers and standard artillery and early warning radars to detect air targets up to 600 meters. The essential conclusion is that the data derived indicate that the low-altitude defense problem is unsolved, but that some improvement is possible. The only weapons specifically cited for such defense are antiaircraft machine guns ZSU-23-4, but no data are provided on them.

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ORGANIZATION FOR THE DETECTION, RECONNAISSANCE AND ENGAGEMENT OF AIR TARGETS AT LOW ALTITUDES
(Conclusions from an exercise)

By

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1. In recent years, the problem of combatting air attack forces at low altitudes has increased. This is related to the change of tactics and operational methods of aircraft, which for the most part have changed over to low-altitude operations, and also to the degree of threat from the air. This is exemplified by military operations in Vietnam and, especially, by the operations of aircraft which, as is known, operated at low altitudes during the conflict in the Middle East.

2. It is known that aircraft always created a considerable threat both for the combat troops and targets deep in the rear, regardless of the altitudes at which the air attacks were launched. However, high-altitude air missions became increasingly vulnerable from the time radar reconnaissance equipment and antiaircraft missile artillery became operational on a large scale for the troops. Therefore, the air forces have been compelled to develop new tactics and operational methods to provide themselves with the capability to overcome antiaircraft defense more easily and to launch surprise attacks against troops and installations with minimum losses. Therefore, air forces have changed over to low-altitude operations and, at the same time, have created considerable difficulties for antiaircraft defense.

3. It is known that the current forces for the most part are not fully prepared to combat low-flying, high-speed aircraft because of the following:

--radar reconnaissance and aircraft guidance equipment is not capable of timely detection and continuous tracking of air targets moving at an altitude below 500 meters; air targets moving at altitudes of 200 meters and lower are actually undetected by most radars, because of the radar return from topographical objects;

--fighter aircraft cannot be used to engage air targets moving at low altitudes because of the difficulty in determining the position of the targets, in guiding friendly aircraft to the targets and in attacking close to the ground;

--currently designed antiaircraft missiles are designated to combat air targets primarily at high and stratospheric altitudes, beyond the range of antiaircraft artillery and certain types of fighter aircraft as well. Most of the existing types of antiaircraft missiles have difficulty in combatting low-altitude air targets because of the difficulty of timely detection of the target and the impossibility of guiding the missiles to the target (distortion of the missile signals transmitted to the missile guidance station and distortion of the control signals transmitted from the missile guidance station to the missile, because of echoes from the ground);

--antiaircraft defense tube artillery was prematurely reduced to a minimum when the first types of antiaircraft missiles became operational, because of the incorrect evaluation of air attack force operations and of the capability of both antiaircraft missile weaponry (being at that time in its infancy) and of fighter aircraft in combatting air targets. Antiaircraft artillery, which is the only current means of effectively combatting low-altitude air targets, may not open fire in time if the air targets are detected late. Therefore, there is the additional problem of organizing the timely detection and warning of antiaircraft artillery about low-altitude targets.

4. The operation of low-altitude aircraft necessitates revision of views on the organization and conduct of antiaircraft defense, a search for new designs of radars and antiaircraft missile and tube artillery, and also a change in the strength ratios of specific antiaircraft defense forces within the combat troops.

5. Providing the troops with new, improved antiaircraft defense equipment is a costly and long-term process. The most effective organization and conduct of antiaircraft defense that is possible with the use of available forces and equipment are the immediate necessity. The Office of the Chief of the Antiaircraft Defense Forces conducted, from 19 to 23 September 1967, a trial exercise which was designed

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for the collection of data pertaining to the following: capability for reconnaissance of low-altitude air targets and for the timely delivery of fire; drafting of principles for the organization and conduct of reconnaissance; and combatting low-altitude air targets.

6. Trials were conducted for the following purposes:

--to determine actual capabilities for the timely detection of air targets at altitudes of 50 to 600 meters by the following antiaircraft artillery radar equipment: early-warning and target acquisition radars (RWSP) and artillery radars (RSA)--by single and overlapping artillery radars;

--to verify actual capabilities for the timely detection of low-flying air targets at altitudes of 50 to 600 meters by means of visual observation conducted by observers at battery command posts, fire control crews, gun crews and forward visual observation posts (WPOW).

7. The exercise was conducted by the method of multiple time measurements from the moment of target detection to the moment of firing the first round and the time of firing, with the use of all aforementioned reconnaissance equipment and several variants for the organization of reconnaissance at the antiaircraft artillery battery, battalion and regimental levels.

8. The following participated in the exercise: directing staff of the exercise; trial analysis group; time-study and inspection officers' group; 80th Antiaircraft Artillery Regiment, including the regimental command post, a full small-caliber artillery battalion, a medium-caliber artillery battalion, battalion command post, battery command posts, artillery radar, directors, one gun battery; flight control officer from the 16th Attack Fighter Division; and three Mig-17 aircraft from the 16th Attack Fighter Division with a total assignment of 16 air missions of 3 or 4 engagements each.

9. The exercise was divided into three phases.

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Phase I. The following problems were examined:

--capability of visual detection of air targets flying at altitudes of 500, 300, 150, and 50 meters (3 or 4 attacks at each altitude);

--time for transmitting reports from the forward visual observation posts (WPOW) to the battery firing positions;

--time from the moment the fire-control officer receives the report on target detection from the WPOW to the moment of firing the first round (firing by gunsight);

--time for firing the guns of the battery, according to parameter;

--optimum distance between the forward visual observation posts (WPOW) and also between the WPOW and the firing positions of the battery.

Phase II. The following was determined:

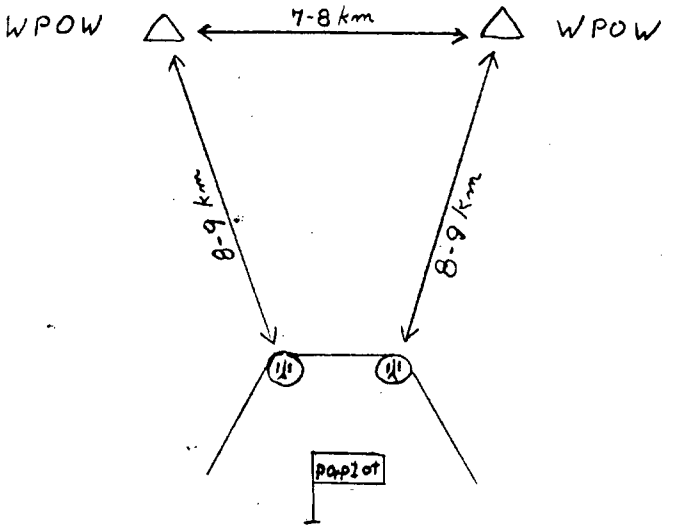
--actual time from the moment the battery commander receives the report from the WPOW to the moment of firing the first round from the guns of the battery by firing with directors or gunsights at air targets flying at altitudes of 400, 200, 100, and 50 meters;

--time for firing by the battery, according to parameter;

--optimum distance between the WPOW and the firing positions of the battery;

--actual capability of using the data from the WPOW for the timely assignment of fire missions by the battery commander.

10. In Phases I and II of the exercise, visual observation by the WPOW and air attacks were conducted by sector (Diagram I).



11. In Phase III, attention was directed at determining the capabilities and actual requirements for the organization of a perimeter visual observation system by using the WPOW on the regimental (battalion) level and also the capabilities for using air-target indication data from the WPOW at the regimental (battalion) command post for assigning the fire missions to the batteries.

12. In all phases of the exercise capabilities for detection of low-altitude targets by the use of regimental radar equipment (early warning and target acquisition radar--"Jawor" and artillery radars Son-9 and "Strzala") were verified.

RESULTS OF THE EXERCISE

13. Radar detection of air targets.

a. The RSWP "Jawor" radars detected only some of the air targets at altitudes above 300 meters and determined only one to four target bearings without the altitude (for

example, of the 15 aircraft movements at H equals 300 to 600 meters, the radars detected 6 at a range of 20 to 40 kilometers). Despite the good deployment of the RSWP radars, most of the targets were detected just before they appeared on the portion of the scope indicating returns from local objects. Operation on TES /unidentified/ (with systems activated for eliminating local objects) was not always effective, because the reflection surface area of fighter aircraft is small and the echo did not always appear on the scope. Aircraft flying at altitudes of 50 to 300 meters did not always appear on the scopes of the RSWP "Jawor" radars.

b) In regard to the Son-9 and "Strzala" artillery radars (RSA), it was found that their capability to detect low-altitude air targets varies. For example, the RSA Son-9 radar detects air targets considerably better than the RSA "Strzala" radar, although they operated under the same conditions. The Son-9 radars detected 70 percent of the targets at ranges of 15 to 28 kilometers, whereas the "Strzala" radars detected 20 percent of the targets at ranges of 12 to /number missing/ kilometers by sector search at altitudes above 100 meters.

14. The ratio for the detection of low-flying air targets by the Son-9 and "Strzala" radars was 3.5:1; the Son-9 radars also detected targets at considerably greater ranges. The detection of air targets by artillery radar (RSA) at ranges of 10 kilometers and more when Vc equals 240 meters per second and less facilitates timely opening and delivery of fire at will. Capabilities considerably decrease when the target is at higher speeds or at altitudes below 100 meters.

15. In the detection of air targets by visual observation, several trials were also conducted to determine the capability for the detection of low-altitude air targets (30 to 600 meters) at a speed of 230 to 240 meters per second (850 kilometers per hour), i.e., at the approximate speed actually used for carrying out combat missions.

16. The following two methods for the organization of visual observation were adopted:

--visual observation organized according to the required tasks of the battery's organic forces at the battery

firing positions, i.e., by observers at the battery command post and the equipment (directors, guns) site;

--visual observation organized on a trial basis with forces detached especially for this purpose at the forward visual observation posts (WPOW).

17. The trials indicated that low-flying targets can be detected by observers without optical equipment as follows:

H equals 50 meters at a range of 2.1 to 2.5 kilometers

H equals 100 meters at a range of 2.3 to 3 kilometers

H equals 200 meters at a range of 2.4 to 3 kilometers

H equals 300 meters at a range of 2.4 to 3.1 kilometers

H equals 400 meters at a range of 2.4 to 3.7 kilometers

H equals 500 meters at a range of 2.4 to 3.7 kilometers

H equals 600 meters at a range of 2.4 to 3.7 kilometers

18. During observation with the use of optical equipment (binoculars, commander's zenith telescope--TZK, rangefinder), the range for the detection of a target at H = 500 meters and less generally does not increase, because of obstruction from topographical features; on the other hand, the range increases by about 100 percent at altitudes greater than 50 meters. The capability to detect targets is certainly reduced by visual observation conducted with the use of optical equipment because of the limited field of vision; this resulted in the reduction of the number of detected targets by 50 percent, because of the short time the targets remained in the field of vision. The best results were attained when visual observation at one position was conducted simultaneously with and without the use of optical equipment. When the distance between the WPOW's was up to 7 kilometers, 90 percent of the targets were detected and reported soon enough with the assistance of the WPOW in the sector.

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19. Capability to use visual-observation data for opening fire. The variants for the transmission and receipt of visual-observation data and the degrees of combat readiness of the subunits varied.

20. Results of the trials of Variant I. The fire-control officer at the battery firing positions received WPOW observation data and decided to open fire on the basis of both the WPOW target indications and the observers at the battery firing positions. It was found that the minimum time for warning the battery about an air attack is 44 or 45 seconds; this required detection of the target at a range of at least 10-11 kilometers, when the target speed is about 240 meters per second. This is dictated by the following time factors:

--about 5 seconds from the moment of detection to the moment of transmitting the report on the target to the battery firing positions;

--about 5 seconds for the receipt of the report by the fire-control officer and designation of the target to the gun and director crews;

--about 3 seconds for tracking and locking onto the target by the rangefinder crew or gunlayers;

--the time required for the projectile to reach the boundary of the zone for effective fire (for 57-mm guns) is 10 seconds; the sum total is 23 seconds or 5.5 kilometers in terms of the distance of flight of the target.

21. The projectile should strike the target at the limit for effective fire, i.e., about 5 kilometers from the firing position; therefore, the total target detection range should be at least 10 or 11 kilometers.

22. If it is assumed that low-flying aircraft can be detected visually at a range of 2-3 kilometers, the WPOW should be moved forward at least 8-9 kilometers in order to give the battery timely warning of an approaching air target; the battery must be in state of readiness No. 1. The battery should be given earlier warning of an approaching air target, if it is in state of readiness No. 2: the time required for the battery to change over from No. 2 to No. 1

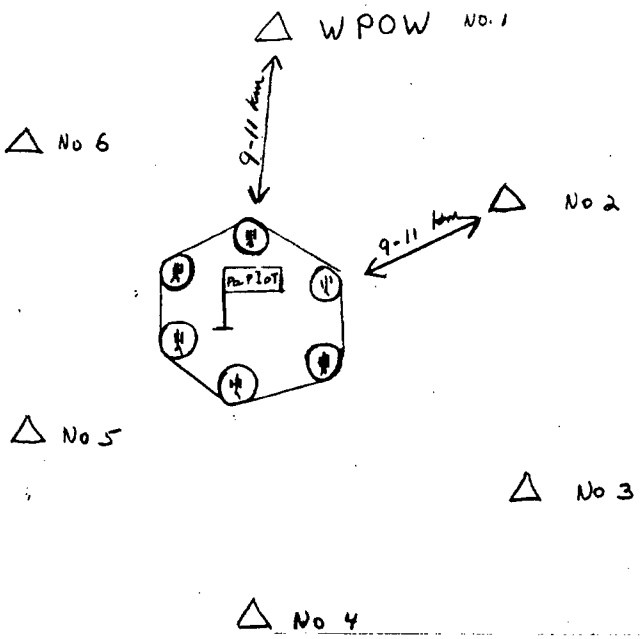
state of readiness is about 60 to 90 seconds. This gives a total time of 100 to 130 seconds, or 24 to 31 kilometers in terms of the distance of flight of the target. Therefore, in this case the WPOW should be moved forward 21 to 28 kilometers. However, this distance of movement of the WPOW forward is actually too great because of the range of the R-109 radios which are used to transmit the reports from the WPOW. It is possible for R-109 radios to maintain relatively uninterrupted communications with the required degree of audibility for a distance of 7 to 10 kilometers in moderately rolling and interrupted terrain, particularly with a power unit. Therefore, the battery could open fire in time during the exercise if it were in state of readiness No.2 and were firing by gunsight only. Firing by director was impossible because of the necessity to activate the systems.

23. Results of the trials of Variant III. The battery commander received the WPOW data and decided to open fire on the low-flying targets. If this decision is made by the battery commander who is at mobile command point (RPD) "Rikin-1" it delays the assignment of the fire mission by 20 seconds on the average, if low-flying air targets are combatted on the basis of visual observation data. This means that the firing time is reduced in most cases if the target data are received by the battery commander after some delay, i.e., when the target enters the visual observation range of the battery firing positions.

24. Results of the trials of Variant III. The purpose of this variant was to verify the actual capabilities for conducting perimeter visual observation and for reporting air targets on the antiaircraft artillery regiment level with the assistance of the WPOW; and also the degree of usefulness of WPOW data on the regimental level for combatting low-altitude air targets.

25. Visual observation was provided by six WPOW's located 9-11 kilometers forward of the outer batteries of the regiment in a ring formation having a radius of about 13 kilometers from the center of the regimental combat grouping (Diagram 2). The average distance between WPOW's was 9 to 12 kilometers. The R-109 radios of the WPOW's,

batteries, and regimental command post operated in a single network.



26. It was assumed that the target indication by a WPOW could be heard only by some of the closer batteries and the regimental command post, which should re-transmit these data in order to warn the other batteries of the regiment. Nevertheless, radar reconnaissance and visual observation were conducted according to the principles in force. Twelve air attacks were launched against the regimental combat grouping from various directions and at various altitudes ranging from 50 to 500 meters.

27. The following are the results of the trials of this variant. The WPOW effected timely detection and transmission of reports on only 5 of the total 12 targets. This resulted from excessively long distances between adjacent WPOW; the distances were up to 12 kilometers, whereas the distance for the detection of low-flying aircraft with the naked eye is 2.5 to 3.5 kilometers. The inaudiblity of the reports transmitted from certain WPOW's must be explained by the long distances in relation to the range of the R-109 radios and their sensitivity to the screening effect of

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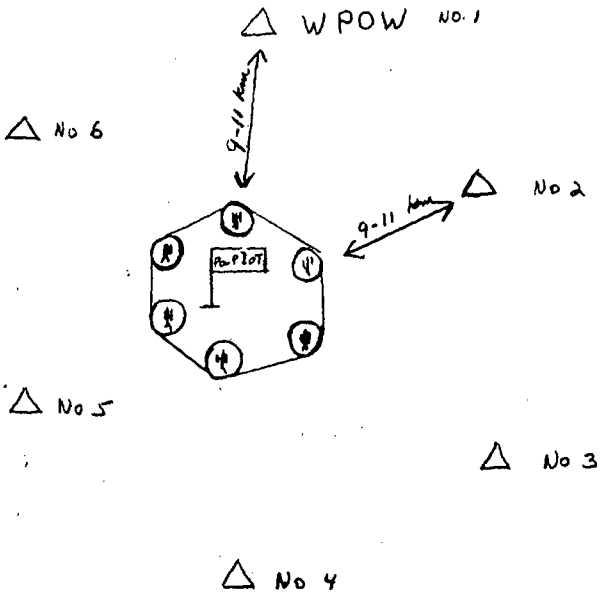

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topographical obstructions.

28. The results of this variant of the exercise indicated that the assigned tasks for perimeter visual observation conducted by the WPOW's were generally fulfilled, despite the inadequate range of the communications equipment in this case. Currently this is one method for timely detection of low-flying air targets and reporting them to firing positions.

29. The exercise fully confirmed the view that low-altitude aircraft movements provide suitable conditions for concealing the approach of aircraft to the targets of the attack and for launching surprise attacks against troops, installations and antiaircraft defense forces; at the same time, they hinder the timely initiation and delivery of fire by antiaircraft defense weapons.

30. Fire effectiveness decreases in proportion to the reduced altitude of aircraft, because the time of their presence in the zone of effective fire is very short--on the order of several seconds, even when the flight parameters are suitable; this permits the firing of several, and infrequently a dozen or so, rounds per gun. The probability of striking the air target depends on the number of rounds fired at a given target during a single firing cycle. In connection with the fact that the presence of a low-altitude target in the zone of effective fire is considerably shorter than that of a medium-altitude or high-altitude target, it is necessary to use a larger number of weapons and to concentrate the weapons in order to achieve the required density of fire against a single target; it is necessary to reject tendencies to disperse weapons (guns of the antiaircraft defense units or subunits for the purpose of providing cover for several far-distant targets with a small number of antiaircraft artillery weapons or antiaircraft machineguns).

31. Multi-barrel, rapid-firing antiaircraft guns, for example, two- and four-barrel 23-mm antiaircraft guns (ZU-23-2 and ZSU-23-4) provide a relatively high density of fire against a single low-altitude target. On the other hand, timely target detection and warning of antiaircraft artillery subunits are required in order to assure timely opening and delivery of fire against a target in a target flight sector as long as possible.

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32. The trials indicated that the detection of air attack forces at low altitudes (up to 600 meters) by current radar equipment is very difficult. In most cases, it is impossible to detect aircraft at very low altitudes of 20 to 200 meters, even when there is no radioelectronic jamming, which radars could eliminate in combat situations.

33. Therefore, visual observation of air attack forces is very important. The action of antiaircraft defense weapons and, consequently, effective cover, depend on a properly organized and effectively operating observation system.

34. The basic task in the visual observation of air attack forces is to give timely warning to the antiaircraft defense firing positions in order to open fire before the airborne enemy is able to locate the target and to launch an attack. Timely opening of fire by the antiaircraft defense forces hinders or prevents the pilot from carrying out his mission, and the objective of providing cover would be achieved even if the enemy were not shot down.

35. With the current organization of antiaircraft tube artillery subunits and units, many difficulties were encountered in providing effective visual observation; they are as follows:

--authorized strength of antiaircraft artillery subunits and units hinders the organization of forward visual observation posts (WPOW);

--radio communications equipment of the antiaircraft artillery units and subunits should have better tactical-technical features;

--theoretical planning and practical experience in the organization and conduct of visual observation in the antiaircraft defense (OPL) system are lacking.

36. It would be necessary to examine the possibility of incorporating organic forward visual observation posts on the level of the antiaircraft artillery regiment, battalion and battery in sufficient numbers to effect the organization of perimeter visual observation (WPOW) on the unit level. The WPOW should include the following: WPOW

commander; an observer; and two radio-telegraph operators-observers.

37. The post should be equipped with a commander's zenith telescope (TZK), a set of field glasses, and a low-power, ultra-shortwave radio to maintain reliable communications at ranges of about 15 to 20 kilometers. The unit should have at its disposal adequate transport equipment for establishing and dismantling the WPOW system.

38. It appears advisable to plan and conduct trial firing at low-flying targets in order to update the following adequately on the basis of the trials: training program; firing instructions; and firing-range programs to provide better preparation for antiaircraft artillery to combat low-altitude targets.

39. It is necessary to use artillery radars (RSA) not only for firing on the basis of early warning and target acquisition radar (RSWP) indications but also for detecting low-altitude targets.

40. Tracking of low-altitude targets would have to be provided by artillery radars in the sectors at angles of elevation of 3 degrees. This would enable the detection of targets flying at altitudes of 300 to 450 meters in open and slightly rolling terrain, depending on the range (width of beam--6 degrees); at a range of 20 kilometers, this would enable scanning the sector from ground level to altitudes of about 300 meters, i.e., altitudes at which RSWP radars have difficulties in detecting air targets.

41. It is not advisable to limit the operating time of the RSA radars to any hourly operating schedule. The operation of the radars under combat conditions will be relatively short because of their easy detection and destruction. Therefore, they should be used effectively.

42. The problem of combatting low-altitude air targets may be solved by putting into operation on a large scale new antiaircraft defense radar equipment and artillery (tube and missile) which are capable of detecting and combatting low-altitude air targets. Until this time, therefore, it is necessary to employ low-altitude air-target combat

procedures and methods which will only partially assure the fulfillment of this task. They may include, among others, those mentioned in this article.

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