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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

1399

20 September 1973

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT (USSR): Soviet Assessment of the Effectiveness of North Vietnamese SA-2 Missile Units

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought." This article assesses the improvement of the effectiveness of North Vietnamese SA-2 missile units against US aircraft through 1967. In addition to modifications of the SA-2 system, areas cited for further improvement are deployment concepts, the centralization of control and the automation of control processes. The tactics employed by US aircraft to lower missile effectiveness, especially maneuver to evade missiles, electronic countermeasures, and the use of Shrike missiles are discussed in terms of the actual or possible responses of missile units. The article also takes up the matter of improving the viability of missile units, primarily by the use of camouflage, dispersal, and better engineer preparation of launch sites. This article appeared in Issue No. 3 (82) for 1967.

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies.

[redacted]

William E. Nelson
Deputy Director for Operations

[redacted]

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[redacted]

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DIRECTORATE OF OPERATIONS

Intelligence Information Special Report

COUNTRY USSR

DATE OF INFO. Mid 1967

DATE 20 Sept 1973

SUBJECT

MILITARY THOUGHT (USSR): Features of the Combat Employment of SAM Troops by the Vietnamese People's Army

SOURCE Documentary

Summary

The following report is a translation from Russian of an article which appeared in Issue No. 3 (82) for 1967 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought." The author of this article is General-Leytenant S. F. Vikhor. This article assesses the improvement of the effectiveness of North Vietnamese SA-2 missile units against US aircraft through 1967. In addition to modifications of the SA-2 system, areas cited for further improvement are deployment concepts, the centralization of control and the automation of control processes. The tactics employed by US aircraft to lower missile effectiveness, especially maneuver to evade missiles, electronic countermeasures, and the use of Shrike missiles are discussed in terms of the actual or possible responses of missile units. The article also takes up the matter of improving the viability of missile units, primarily by the use of camouflage, dispersal, and better engineer preparation of launch sites. A parallel article on North Vietnamese air defense in general was disseminated in [redacted].

End of Summary

[redacted] Comment:

General-Leytenant S. F. Vikhor is Deputy Commander-in-Chief of the Rocket Troops of Soviet Air Defense of the Country.

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T-O-P S-E-C-R-E-T

FEATURES OF THE COMBAT EMPLOYMENT OF SAM TROOPS BY THE VIETNAMESE PEOPLE'S ARMY

by
General-Leytenant of Artillery S. Vikhor

SAM troops of the Vietnamese People's Army (VPA), in the two years of their combat activity, have made a significant contribution to the defense of the Democratic Republic of Vietnam (DRV) against the air raids of American interventionists; and at the present time they constitute the basis of the air defense of the republic. As of 1 September 1967, they have destroyed approximately 530 American aircraft, of which up to eighty percent are the latest types of fighter-bombers and carrier attack aircraft.

Despite the considerable amount of antiaircraft artillery in the VPA, and also the presence of fighter aircraft, the principal burden of combat with American aviation in the DRV still falls on SAM troops, which cover the basic political-administrative and industrial centers, as well as the most important individual installations located in the southern and central parts of the country. At the same time, SAM troops are widely employed to defend installations on lines of communications linking the country with China, the port of Haiphong, and southern areas.

SAM troop units of the VPA are armed with SA-75M (Dvina) systems with V-750V(11D) missiles modified in 1957-1958.

The systems have been modified, as a result of which it has become possible to deliver fire at altitudes down to five hundred meters and to destroy ground and water surface targets. The systems have equipment which links them to reconnaissance and target designation sets (P-12M) and can deliver "pursuit" fire and also fire on drifting balloons. However, the lack of anti-jamming defense equipment and the poor capabilities for destroying targets maneuvering to avoid missiles do not permit the successful conduct of combat against targets under complex conditions.

At the present time it is planned to modify the SA-75M systems for the purpose of broadening their capabilities to destroy maneuvering targets. Improvement in the missile guidance methods is envisaged.

The organization of SAM troop units of the VPA is similar, in principle, to that of the Soviet Union. The basic tactical entity, the SAM regiment, is composed of four SAM battalions and one technical battalion. The difference from our T/O structure is that antiaircraft artillery subunits have been incorporated into VPA regiments, the number of certain specialists in the combat crews of SAM and technical battalions has been doubled, and individual crews have been increased to three shifts. For direct protection of the sites, two or three 37 millimeter (57 millimeter) automatic antiaircraft guns and two or three platoons armed with ZPU-2 or ZPU-4 have been incorporated into the complement of every missile battalion. There is a deputy for antiaircraft artillery in every SAM regiment and battalion.

SAM troops of the VPA, created with the help of the Soviet Union, constantly increase in numbers, and, in conjunction with this, the tactical and firing skill of the personnel of the units and subunits is improving.

Taking into account that a previous issue of the Collection of Articles of the Journal has already published material which gave a general analysis of the actions of VPA SAM troops, in this article we shall only examine several principles of the combat employment of SAM troops, individual questions about their control, and also the features of SAM firings and those measures which are being adopted to assure the viability of combat formations.

Principles of the combat employment of SAM troops. The methods of combat employment of SAM troop units of the VPA are fundamentally influenced by the nature of actions by US aviation, by local natural conditions, and by the composition of the DRV air defense forces.

Initially, when there were few SAM troop subunits, actions from "ambushes" were predominant in their combat employment tactics. SAM battalions, by making wide-ranging moves and frequent site changes, strove to cover as many installations as possible and, by utilizing the element of surprise, to inflict the greatest losses possible on the enemy. These tactics were employed sometimes for political considerations: the appearance of SAM battalions in isolated provinces and districts helped raise the morale of the local population. Results of SAM troop combat actions at this time were very high: 1.25 missiles expended for every aircraft downed.

Further expansion of military actions required more dependable protection for the vitally important centers of the country. The necessity for this became particularly obvious in mid-1966 when American aviation succeeded in delivering strikes with impunity against fuel storage tanks in the Hanoi and Haiphong areas. SAM troop units protecting these cities were unable to offer adequate opposition to the interventionists because more than half of the combat effective SAM battalions were deployed for action from "ambush" in areas which were more than 120 kilometers from the main grouping.

From this time on, an all-out concentration of forces for the defense of the most important installations has become characteristic of SAM troop tactics. The air defense created for the cities of Hanoi and Haiphong was a zonal-installation grouping which assured a dense zone of fire from all directions. Moving battalions after firing began to be practiced more infrequently; within the limits of the grouping it was accomplished in such a manner as to retain fire coordination with neighboring battalions. All this raised the overall dependability of the defense of installations. From mid-1966, to overcome the SAM defense, American aviation was forced to adopt new tactical approaches, to increase sharply the intensity of its radar countermeasures, and to use Shrike homing missiles to neutralize SAM complexes. The experience of combat actions confirmed that American aviation cannot overcome well-organized air defense without using measures aimed at lowering the fire effectiveness of SAM systems.

However, a portion of the SAM troop strength of the VPA, as formerly, is used to conduct combat actions from "ambush" outside the limits of the main grouping covering the most important installations. Such actions permit a slight increase in the number of downed aircraft, but weakening the defense of installations is fraught with grave consequences. US aviation, in carrying out intense aerial reconnaissance, finds out quite quickly the regrouping of SAM troops defending installations. There are many known instances when breaches of the system of fire were immediately exploited by the air enemy to penetrate with impunity to strike objectives. Accordingly, aircraft would confidently take advantage of the gaps formed in the kill zones of two adjacent battalions and get to the objectives without opposition. Thus, when delivering massive raids on the Hanoi suburbs in December 1966, aircraft flight routes were chosen so that the aircraft approaches to the objectives were from those directions where the SAM defense was weakest.

This was confirmed by the testimony of a captured flier and by a map taken from him on which were drawn, quite accurately, not only SAM battalion sites but also the kill zones of the complexes at various altitudes. Information about the air defense pattern was obtained by thorough and intensive aerial reconnaissance carried out by pilotless and piloted means of the interventionists.

Analysis of the experience of the VPA air defense shows that, in order to make effective use of the fire capabilities of SAM troops, it is necessary to establish a unified all-around system of fire at a single installation, or group of installations, which would assure hitting air targets at any altitude. The reliability of antiaircraft cover is directly dependent on the degree to which SAM troop forces are concentrated for the defense of installations. Striving to cover as many installations as possible leads to a dissipation of forces and means and does not permit the fullest possible exploitation of the fire capabilities of the SAM armament.

Features of the control of SAM troop combat actions. In general, the system of controlling the combat actions of SAM troops is based on the very same principles adopted by our Air Defense Troops of the Country. However, the conditions for implementing control in the DRV are much more difficult. American aviation operating against DRV installations simultaneously conducts intensive flights along the Gulf of Tonkin coast and in areas along the Laotian border. Unceasing day and night flights by American aviation, at distances of 100 to 150 kilometers from SAM battalions, keep subunit combat crews under stress, exhaust them physically, and also dull the vigilance of personnel. Herein lies one of the causes why SAM battalions, in most instances, do not succeed in readying themselves to deliver fire and then firing at targets, even though they have three combat crew shifts, one of which is always on duty at the equipment.

The difficulties of control under such tactics by US aviation are further aggravated because information concerning enemy aircraft flights is received from radar troops with a delay of five to seven minutes or more (this occurs in part because of a shortage of communications means), and, in some instances, because it is not transmitted at all. As a result of this, SAM battalions are unable to fire on up to fifty percent of the targets.

Under these conditions, the SAM troop command began to employ their organic P-12M radar reconnaissance and target designation station as the basic reconnaissance means against the air enemy; with their help, autonomous radar coverage was established. Missile guidance stations are also often used for this by scanning specific sectors of the air space. Data from the duty radar reconnaissance and target designation stations are transmitted through unit command posts to other battalions and are used basically to bring subunits to the ready to repulse enemy air raids. This undoubtedly helps improve control, but is still far from eliminating the basic difficulties inherent in its organization.

SAM battalions acting from "ambushes" do not, as a rule, have communications with the main grouping. Commanding officers of these battalions receive notification directly from radiotechnical troops and utilize radar reconnaissance and target designation stations and missile guidance stations for reconnaissance.

All this has led to the need to employ fundamentally decentralized control. Commanding officers of battalions incorporated into zonal-installation groupings, not to mention those battalions operating from "ambushes," have been granted wide authority to conduct combat actions independently. As regards unit commanding officers, their basic role consists of bringing subunits to the ready and of assigning to battalions very general tasks for the conduct of battle. This is stipulated for the following reasons. Because of the limitations of communication channels at unit command posts, the radar information from battalion radar reconnaissance and target designation stations is processed only when single targets are present. When the situations become complex, radar information at the command posts is, in essence, not processed and unit commanding officers are unable to correctly effect target allocation. That is why there is no combat direction of SAM battalions from unit command posts when repulsing massive raids echeloned in depth. When tasks are assigned to battalions, all that is designated are the sectors or axes on which enemy aircraft are to be destroyed. Battalion commanders have complete independence in selecting targets and making decisions to destroy them.

This kind of control organization is characterized by significant deficiencies. Autonomous conduct of battalion combat actions does not always permit the fullest exploitation of the

fire capabilities of SAM troop groupings, particularly if it is necessary to carry out a move or to concentrate fire while under very heavy attack.

Thus, an analysis of SAM battalion battles in 1966 and 1967 to repulse massive raids on Hanoi and Haiphong testifies that the fire effectiveness of SAM troops under high-density air raids (four or five aircraft per minute), decreases almost by a factor of two in comparison with ordinary fire on single targets and small groups. What was necessary in a situation like this was precise target allocation and concentration of fire on the most dangerous targets. However, most of the autonomously operating SAM battalions (eighty to eighty-five percent) delivered disorganized fire on the targets from minimum permissible ranges and, as a rule, without preparing initial data. Thus a number of targets were not fired upon. As a result, effectiveness of fire was inadequate and the enemy, in a number of instances, was able to deliver strikes with small losses to himself.

In other cases, decentralized control led to the unsound concentration of fire on one and the same target. In November 1966, for example, to destroy two pilotless PQM-34A reconnaissance aircraft flying at an altitude of 17,000 meters, six SAM battalions opened fire almost simultaneously, expending twelve missiles. It was determined later that the PQM-34A reconnaissance aircraft were destroyed by missiles from the first battalion that opened fire. The remaining battalions launched eight missiles for the "final destruction" of the falling target. A similar case was also noted in January 1966, when two battalions expended seven missiles in delivering fire on a PQM-34A reconnaissance aircraft.

Decentralized control requires accurate notification to the SAM battalions of the flights of friendly fighters. In the VPA, however, information about the location of its own aircraft is passed on to battalions with much delay, and in isolated instances, not transmitted at all. When identification equipment in SAM complexes and fighters has been used very inadequately, this has led, in a number of cases, to the firing upon and destruction of their own aircraft returning from a mission.

Thus, decentralized control does not fully guarantee the effective use of the fire capabilities of SAM troops, but although the conduct of autonomous combat actions by SAM

battalions may be justified in isolated cases, unit commanders and staffs must always strive to assure centralized control of firing subunits. Centralized control may produce the greatest effects if it is based on the use of automated systems which permit the speedy receipt, processing, and presentation of radar information at command posts. In units without such systems the command posts must use remote displays of radar stations. By receiving initial radar data in an efficient manner, commanders and staffs will have more flexible and effective control of the combat of SAM battalions.

Features of SAM firings. The discovery of the frequency characteristics and weak points of the VPA SAM systems has allowed US aviation to implement effective measures to lower the fire effectiveness of SAM troops. Among these measures are, first of all, maneuvers to avoid missiles, the use of radio jamming, and Shrike anti-radar homing missiles. Let us consider how, on the basis of Vietnam war experience, SAM troops should be employed under these circumstances.

Fire on targets maneuvering to avoid missiles. American aircraft, upon receiving a signal from onboard equipment that missile guidance stations have begun tracking them and a signal the instant a missile has been launched, will immediately (within two to eight seconds in seventy to eighty percent of all cases) begin maneuvering to avoid the missile. If the instant the missile is launched goes undetected, then, based upon visual observation or a signal from aircraft in the support group, it is still possible to execute a maneuver within eight to twelve seconds before the encounter with the missile. Maneuvers by targets are, as a rule, carried out in the vertical (diving) or horizontal (turning) planes, and in certain cases, by a combination of the two, by half-spirals.

Diving is most effective in lowering the effectiveness of fire because, while the missile is in flight, either the aircraft leaves the kill zone limits or it gets down to an altitude close to the minimum sighting limits of the SAM system. This results, in the first instance, in the loss of the missile, and in the second, to a three to five time increase in target-tracking error.

To raise the effectiveness of fire of SAM systems against maneuvering targets, it is necessary to define absolute SAM launch ranges which will assure an encounter by the missile with the target within the kill zone limits. For SA-75M

systems, against targets flying at an altitude of two to two and a half kilometers and at a speed of 200 meters per second, these ranges lie within the limits of fourteen to sixteen kilometers. That is why VPA SAM battalion crews conduct missile launches at minimum permissible ranges with, as a rule, manual target tracking. But enemy aviation has the capability, by increasing its speed (using afterburners) of rapidly departing the kill zone into the dead space of the SAM system and of carrying out its bombing by the toss method. This deficiency has been partially eliminated at present by reducing the dead space and thereby has led to an increase of the absolute launch zone which, under the previously cited conditions, has now been limited to ranges of sixteen and twelve and a half kilometers.

Target maneuvers have been accompanied by abrupt non-linear changes in coordinates, which have required changes in the operating modes of the missile guidance stations and, consequently, changes in the guidance methods of the missile in flight. This leads to missile oscillation, to increased guidance errors, and, in the final analysis, to lowered effectiveness of fire. Planned technical modifications of the SA-75M system will permit an expansion of its fire capabilities and a decrease in the effects of maneuvering on the accuracy of guiding the missile to the target.

Of great importance in raising the effectiveness of fire is the training of combat crew personnel, who must, in the first place, know how to determine quickly and correctly the initiation and nature of a maneuver, know how to accurately track maneuvering targets, and know the particulars of the combat use of technical equipment.

Fire under radio jamming conditions. The nature of the jamming employed by the enemy and its influence on SAM troop combat actions is diverse. Passive jamming was conducted by dropping dipole reflectors and by firing ahead of the aircraft special shells which generated clouds of metal-coated strips. These did not significantly affect crew operations. Enemy combat aircraft avoided flying into or near the jamming cloud. But the presence of a zone covered by jamming forced combat crews to focus attention in this direction, which, under conditions of intense enemy air action, considerably complicated combat work.

Since December 1965, to all intents, the enemy has given up the use of passive jamming; first, because of its limited

effectiveness outside SAM system kill zones (in four cases entry into the kill zone resulted in the destruction of the aircraft delivering the jamming); and second, as a result of the shift of US aviation to low altitude flights, the effect of passive jamming was short-lived. In the future, one must assume that jamming equipment and methods will be improved; therefore the task of training personnel to conduct combat actions under intense jamming conditions is still an urgent requirement.

SAM troop combat actions have been significantly complicated by active jamming: impulse response, and selective and barrage noise jamming. Lately active jamming has been used simultaneously with maneuvers to avoid missiles.

Impulse-response jamming was, as a rule, produced by combat aircraft of a strike group. The sudden appearance on the display screens of several false targets at a range short of the actual range, and the limited time to analyze the air situation, greatly hampered combat work. Such organizational-tactical measures as changing the impulse frequencies of probe impulses, switching levels, momentary switching of transmitters to dummy load, and target tracking by several missile guidance stations, permitted lowering to a minimum the effect of these jammings.

The situation is more complicated as regards noise jammings. Initially they were produced at weak and medium intensity levels by aircraft from a strike group usually flying on the same plane. When using technical defense means ARU [automatic regulation of amplification] and MARU [instantaneous automatic volume control in radar], a target within such jammings would be reliably detected at ranges of twenty-three to twenty-five kilometers and fire would be delivered with adequate effectiveness. Subsequently the intensity of noise jamming increased sharply: during raids the enemy started to use two or three special jamming aircraft which flew at distances of 60 to 120 kilometers away. And aircraft of the strike group continued jamming at the same time. Experience showed that the presence of high-intensity noise jamming creates an extremely difficult situation for combat crews.

The most practical means of overcoming these difficulties at present can be: fighter actions against the enemy special jamming aircraft flying 60 to 120 kilometers away; employment in SAM

groupings of systems with varied frequency ranges; and use of missile guidance stations with automatic frequency tuning.

Combat actions under conditions in which Shrike homing missiles are employed. As a rule, American aircraft carried out Shrike missile launches from a range of fourteen to twenty-eight kilometers during flights with small course profiles (zero to six kilometers) at altitudes of from 0.8 to four kilometers. At present there has been a noticeable tendency to increase the altitude, which has made it possible to launch these missiles from a range of twenty-five to thirty kilometers.

Under certain operating modes of the missile guidance stations, the launch and flight of a Shrike missile are observed reliably on display screens. This permits the use of special measures to defend systems from Shrike missile effects.

An analysis of the guidance errors of this missile indicates that, upon implementation of target search by a missile guidance station and the operation of two missile guidance stations in a single sector, the deviation of a Shrike is such that the "survivability" of a complex is assured by a probability factor approaching one.

The most effective means of defense against this missile is the smooth turning away of the missile guidance station antenna with the subsequent switching of the transmitters to dummy load. The amount of deviation by the Shrike missile is proportional to the transition period of the missile guidance station to dummy load and antenna turn-away time. The most advisable antenna turn-away time is two to three seconds and the transition period to dummy load must be no less than three kilometers (twelve seconds of Shrike flight). Experience shows that this measure is highly effective. Hits on SAM systems by Shrike missiles were noted only in those cases when the indicated recommendations were not implemented. But the defensive measure set forth is not lacking in deficiencies. The temporary cessation of SAM troop combat actions makes it easier for enemy aviation to accomplish its combat mission. Therefore, those tactical methods of defense against homing missiles which cause the firing capabilities of SAM systems to be lowered may be considered acceptable only provisionally, until this problem is solved technically.

Measures to increase the viability of SAM troop combat formations. During the period of July 1965 to 1 September 1967, American aviation, with the aim of disorganizing the SAM defense,

delivered more than 140 strikes against SAM troop sites. As a result, several missile guidance stations were irretrievably lost, as were approximately sixty-five missiles, and more than ten launchers and transport-loading vehicles.

Reconnaissance preceding the strike was carried out by pilotless PQM-34A and 147j reconnaissance aircraft and by RF-101, RF-4 reconnaissance aircraft, and by others. Fighter bombers and carrier attack aircraft were also used for this purpose. During various periods, reconnaissance flights comprised up to one-third of all American aircraft flights over the territory of the DRV. Reconnaissance was conducted over one to two days or two to three hours before strikes were delivered on the sites. Lately, strikes on SAM troop sites have been noted during the course of a raid on an installation, immediately following discovery of the deployment of the battalion.

Bombs, 70-to-127-millimeter free rockets, machine-gun and cannon fire, and Shrike homing missiles are used to neutralize SAM troops. At first these missiles were used to neutralize gun-laying radar stations operating in the automatic tracking mode, but after updating (since May 1966), they were used to strike missile guidance stations. The method of using Shrike missiles was also changed. Instead of launching single missiles from a distance of fourteen to eighteen kilometers, the Americans started, from the end of 1966, to shift over to launches by groups (of two to four missiles) from a distance of twenty-eight to thirty kilometers. The neutralization of SAM battalions by Shrikes is carried out by several groups of aircraft operating from various directions. As a rule, each group includes one reconnaissance aircraft, up to two jamming aircraft, and one or two Shrike delivery aircraft. In 1966 and 1967 the enemy used more than eighty Shrike missiles. In tens of cases, so much damage was inflicted on technical equipment that battalions lost their combat effectiveness for periods ranging from several days to two to three months.

Taking into account that SAM battalions were practically undefended from low altitude actions against them, the VPA command is organizing cover for them by antiaircraft artillery batteries and antiaircraft machine guns. To this end, use is made of the organic means of SAM battalions (thirty-seven and fifty-seven millimeter antiaircraft gun batteries and antiaircraft machine-gun platoons) as well as a portion of the forces of antiaircraft artillery regiments which, in joint defense, have been given the task of covering SAM troop combat

formations. Experience has shown that the effectiveness of such cover depends largely on the organization of combat duty and the training of antiaircraft artillery and antiaircraft machine-gun personnel. Because of the inadequate effectiveness of its fire at low altitudes, medium caliber antiaircraft artillery (eighty-five and one hundred millimeter) has not been used to cover SAM troop combat formations.

Increasing the viability of SAM troop combat formations can also be achieved by dispersing combat equipment, improving engineer preparations, and camouflaging elements of the combat formations.

Dispersal of combat formation elements is widely practiced in both SAM and technical battalions. Launchers are usually deployed at the sites at the maximum permissible distance from the vans of the missile guidance stations. When terrain conditions do not permit the deployment of all the launchers, then only a portion of them (three or four) are brought to combat readiness. Transport-loading vehicles, with the missiles loaded on them, are concealed 1000 to 2000 meters from the site. During combat only essential personnel are kept at the SAM battalion sites. Crew members of other shifts, towing equipment, rear services, etc, are located 500 to 1000 meters from the site. The institution of these measures considerably reduced losses in technical equipment and personnel.

Analogous dispersal is also put into effect in technical subunits. All technical battalions of regiments are deployed in field type positions, located in the middle of unit combat formations at distances not exceeding fifty kilometers from railroad unloading stations. The main position contains equipment and material of the technical stream, eight to ten ready missiles on transport-loading vehicles, and, in addition, sustainer components with assembly elements for not more than ten to fifteen missiles. The remaining missile and special fuel reserves are placed in several locations five to twenty kilometers from the main position. Thanks to such dispersal, technical battalions had practically no losses in 1966 and 1967; but their productivity under these conditions was lowered, since they were unable to prepare more than two missiles an hour.

Camouflage work on launching and technical sites substantially increases the viability of SAM troops and in many cases assures successful battalion actions, particularly when

conducting combat from "ambushes." Camouflage of material and equipment is accomplished by the crews with great thoroughness before and during the course of battle. For this purpose, in addition to T/E means (camouflage nets, camouflage paint, etc.), materials at hand in the field are widely used. Branches of trees and bushes cover not only the equipment and material of launching batteries, but also the missile guidance station van; and the receiving and transmitting van (Pa) is switched off. The thoroughness and naturalness of the camouflage is checked and maintained daily. After missile launches, the disturbed camouflage is immediately restored. This work is accomplished with great skill, as attested to by instances in which American aircraft delivered strikes, not on the camouflaged launching sites, but on dust clouds (formed as a result of missile launches) which had been carried sideways by the wind.

To better exploit the camouflage properties of the terrain, the grass cover on roads within the confines of SAM battalion launching sites is not removed. To avoid detection of a missile launch through revealing signs, particularly the formation of dust clouds, in the daytime crews wet down the area around the launchers.

The important role played by camouflage may be judged by the following example. At the beginning of 1967 a SAM battalion took up a combat formation at night in an area where RB-66 jamming aircraft flew sorties. In the morning enemy aircraft, including a pilotless PQM-34A reconnaissance aircraft, flew over the launching site four times. In the daytime, when an RB-66 showed up in the area, it was immediately destroyed by the fire of one battalion. Attempts of American reconnaissance to locate the battalion and deliver a strike on it were fruitless.

Great efforts are made to camouflage technical battalions. Combat work in the preparation of missiles, and also the delivery of them to the battalions, is carried out only in darkness. At daybreak all types of work cease in the technical battalions, the movement of columns with missiles stops, and equipment and material are thoroughly camouflaged.

Engineer preparation of sites. An underestimation of these measures during the initial period of combat actions led SAM battalions to suffer appreciable losses in technical equipment and personnel. Several cases were noted in which hits by bullets, bomb fragments, and free rockets caused missiles on

launching mounts to be blown up. At sites not provided with engineer preparations this led to the detonation of missiles on adjacent launchers and on transport-loading vehicles located in platoon shelter areas. Losses due to direct enemy action, accordingly, were considerably less than those from the warhead fragments of their own missiles. Thus, in March 1966, during a strike on one of the battalion sites, a missile on a launcher was damaged by free rocket fragments. The missile fuel was ignited and caused the warhead to explode. This resulted in damage to four more missiles, one of which was on a transport-loading vehicle in the platoon shelter. Hits on missiles often cause them to fall off the launcher and even from transport-loading vehicles, which inevitably causes damage to the launchers and transport-loading vehicles.

Initially, concealment of the vans of missile guidance stations was also carried out with inadequate thoroughness. When preparing the ground for the site, revetments were usually put up around the receiving and transmitting van (Pa), and sometimes a general revetment was put up for all the vans of the missile guidance station. Such engineer preparations did not provide dependable defense for the technical equipment of the technical battery. Hits by bombs and free rockets, and also by Shrike missiles, caused considerable damage to combat equipment. Thus, a Shrike burst five meters from the receiving and sending van (Pa) at one of the battalion sites (November 1966) put all the technical equipment of the missile guidance station out of action for a long period of time.

Lately, paramount importance has been attached to the improvement of engineer preparations at SAM troop sites. Full-scale emplacements are being dug for launchers, and separate shelters are being constructed for every missile guidance station van. The cable harness, the most vulnerable element of the technical equipment, is thoroughly covered in specially prepared trenches. Shelters, with a light cover affording protection from fragments and bullets, are being provided for personnel in the combat equipment locations. Engineer work is being done by SAM subunits and specially formed units. The local populace is widely enlisted to help the troops.

The construction of dummy sites increases the viability of SAM troop combat formations to a significant degree. The skilful preparation of dummy launching sites and the simulation of missile launches from them by using land mine bursts and smoke pots have repeatedly deceived the enemy. American aviation has delivered twenty-five percent of its strikes on dummy sites and on sites

vacated by battalions after combat. Deception of the enemy was particularly successful when battalion firings were conducted simultaneously with simulated missile launches from a dummy launching site located three to five kilometers from the real one. The VPA command has formed special engineer units, which are organizationally part of the air defense, to establish and maintain the system of dummy sites.

In the course of combat with the American interventionists, SAM armaments have demonstrated high design and operating reliability, which has largely predetermined that they can be restored directly under field conditions. The standardization of many assemblies and components, the simplicity of design, and the dependability of the equipment have made it possible to conduct repair and recovery work at the major overhaul level with the facilities available in the regimental shop and by personnel with very limited special training. During combat actions, repair organs of the VPA SAM troops have carried out up to eight major overhauls of systems, right up to the complete restoration of a missile guidance station. It takes from several days to two to three months to restore a system. The lack of major overhaul facilities has only meant that restoration work takes longer to complete. This work is carried out directly under field conditions with the strictest observance of camouflage measures.

* * *

The experience of SAM troops of the VPA has shown that American aviation, in its combat actions in Vietnam, is constantly perfecting methods and ways of overcoming air defenses. To achieve its established goals with minimum losses, the USAF command is employing new tactics and also the latest means of countermeasures for the primary purpose of lowering the firing effectiveness of SAM systems. Although US tactical and carrier aviation has not by any means revealed all of its capabilities, one may already assume that maneuvering to avoid missiles, radar jamming, and the delivery of strikes against sites by Shrike homing missiles will be widely employed in future USAF tactics.

The methods of SAM troop combat actions must be improved by increasing their effectiveness of fire against low-altitude and maneuvering targets, and also against targets executing raids under cover of intensive jamming. It is particularly important at present that SAM troops master the procedures for combat against an air enemy who employs Shrike homing missiles against them.

Vietnam war experience has confirmed that the effective employment of the fire capabilities of SAM systems depends on the nature of the groupings which are established to protect installations. SAM troop combat formations defending an installation or a group of installations should be so arranged as to create a solid all-altitude fire system and to assure centralized control of the grouping. The automation of control processes is one of the principal tasks in resolving the problem of the effective utilization of SAM armaments.

The question of increasing the viability of combat formations must be a subject of constant concern. Engineer preparations of sites, and the camouflaging and dispersal of combat formations, materiel supplies and armament, are ways in which this important problem can be solved.