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Table of Contents

AIR AND SPACE RECONNAISSANCE IN ARMED CONFLICT

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Every time that military theoretical thought focuses attention on the essence of the changes occurring in military affairs, it notes not only the basic revisions in the nature and methods of armed conflict, but also the sharp increase in the role of reconnaissance in military operations of various scales and in war as a whole. Actually, modern weapons, especially ballistic missiles equipped with nuclear warheads, make it possible to inflict strikes of enormous power in a short period of time and at practically an unlimited range. And if enemy preparation to inflict such a strike is not discovered in time, it is possible to sustain a surprise nuclear missile attack and be in a critical situation from the very beginning of the war. No less important is the fact that the armed forces will be able to use their might purposefully and with the greatest effect only if they have adequate and reliable data concerning the composition, grouping, and nature of preparations of troops of a potential enemy, his most important military and economic targets, and the system used for their defense. This is not new. But in modern conditions it has acquired a special sense, since the successful employment, at the beginning of the war, primarily of strategic weapons, which advance victory over enemy in a decisive manner, depends upon intelligence data. The situation is similar to the role of reconnaissance in operations of the branches of the armed forces. Their course and outcome are determined to a great degree by the timely ascertainment of the location of enemy nuclear weapons and the disclosure of the concentration and basic groupings of the [enemy] troops and various important targets.

The change in the nature and methods of armed conflict is accompanied by an increased volume of reconnaissance tasks and the fact that they have become considerably more complex. In modern conditions, groupings of armed forces and important targets are located in practically all the territory of a state or coalition of states, and the most important targets are weapons capable of strategic assault (launch installations for intercontinental rockets, missile-armed submarines, strategic aviation at airbases), which are located, as a rule, deep in the interior of the country or in distant water areas, and are in constant readiness for action.

This has made it necessary to conduct continuous observation of extensive regions of the land, seas, and oceans, and also of airspace and outer space. The transition to dispersed battle formations and the increase in the depth of the operational deployment of troops have required that we increase the depth of reconnaissance in theaters of military operations accordingly. It has also become more difficult to perform reconnaissance because its main targets, namely weapons capable of a nuclear attack, as a rule are of small dimensions, and their locations are well-camouflaged fixed or mobile targets.

The enormous flight speeds of ballistic rockets, and the fast-moving nature of battles and engagements, the dynamic nature of the development of events, and the sharp changes in the situation, require that reconnaissance be conducted with the highest efficiency. Information must be rapidly obtained, processed, and transmitted to the organs interested in the least possible time.

Requirements have also increased for reliable data and accurate determination of the positions of troop groupings and targets, since the effective employment of very powerful weapons depends upon this. Increasing sharply is the significance of those methods and forms of reconnaissance which even before the beginning of military operations make it possible to disclose the preparation of the opposite side for unleashing a war and provide the armed forces with the data necessary for inflicting the worst blows against them.

In these conditions, technical reconnaissance in general, and especially aerial photography and the application of radioelectronic reconnaissance equipment have acquired primary importance.

On the basis of data from the foreign press, let us consider briefly the capabilities of various types of intelligence, their application in military operations, and the most characteristic trends in their development.

It was established long ago that technical reconnaissance equipment may be used with the greatest effect if we place them in aircraft: in this case, the sphere of activity of radiotechnical and infrared equipment expands sharply, the field of view of photoapparatuses increases, and the capabilities of radar reconnaissance stations increase. Reconnaissance from aircraft most completely satisfies the requirements of continuous observation, not only throughout the entire depth of theaters of military operations, but also beyond their limits. In this case, accuracy of intelligence data and good documentation of it is ensured. Besides this, even without special reconnaissance apparatus a pilot may collect very valuable and important information during a flight.

leading places among types of reconnaissance as early as the years of World War II. With its aid, the basic mass of information necessary for the preparation and conduct of army and front operations was obtained, and also data concerning important targets in the enemy rear, the intensity of operations of railroad and motor-vehicle highways, the results of aerial attacks on cities, enterprises, structures, and much other information.

In the postwar period, the development of aerial reconnaissance methods and equipment continued at very high rates. Equipment of increasing complexity and diversity, including radio, radar, and television equipment, cameras for various purposes, infrared reconnaissance devices, etc., were installed aboard reconnaissance aircraft. The carriers of this reconnaissance equipment were also continuously improved. The maximum range, speed, and flight altitude of reconnaissance aircraft, increased twofold or threefold as compared to the years of World War II, and still continue to increase. Thus, the latest models of tactical reconnaissance aircraft (the RF-4C) have a maximum speed of about 2500 km/hr, a ceiling of 24,000 m, and a flight range of more than 4000 km. The new US SR-71 strategic reconnaissance aircraft, which is on the verge of being introduced into the armament will supposedly have even higher flight characteristics. It is estimated that this aircraft will be able to make a prolonged flight at an altitude of 24,000 m at a speed of 3000 km/hr, and briefly develop a speed of up to 3700 km/hr and rise to an altitude of more than 30,000 m. The reconnaissance equipment installed aboard the aircraft will provide for scanning an area of about 260,000 square kilometers in one hour of flight at a speed of Mach 2.5 and an altitude of 27,000 m. Pilotless reconnaissance aircraft and also automatic drifting balloons have been widely distributed.

But, in spite of this, aerial reconnaissance still has a number of limitations. In the first place, the penetration of aircraft into the airspace of the opposing side or into the zone of military operations of ground troops or naval forces incurs great danger, owing to the sharp rise in the effectiveness of air defense. In the second place, conducting aerial reconnaissance in peacetime over the territory of other states violates their sovereignty, which is intolerable from the standpoint of international law. The ruling circles of the US are striving to make up for these limitations in the capabilities of aerial reconnaissance by the application of space reconnaissance apparatuses, which include artificial earth reconnaissance satellites, spaceships, aircraft capable of operating in space, and orbital aircraft.

The use of artificial satellites and other space devices will incommensurably expand the capabilities of technical reconnaissance. With reconnaissance equipment on board, they can conduct reconnaissance on a global scale, inspect enormous spaces in a short period of time, and rapidly transmit the accumulated data to intelligence centers. However,

with respect to flexibility and efficiency. With respect to the degree of detail in the data obtained, space reconnaissance is inferior to aerial reconnaissance. Therefore, they do not replace each other, but only supplement each other.

Aerial reconnaissance, used in combination with artificial reconnaissance satellites, acquires qualitatively new features -- it becomes an air and space effort.

With respect to the nature of the tasks being executed, air and space reconnaissance is categorized by western military specialists as operational, tactical, and strategic.

Operational and tactical reconnaissance obtains data concerning the enemy over the region of military operations and in the immediate rear. It is conducted mainly by piloted and pilotless reconnaissance aircraft for purposes of detecting the launching positions of tactical rockets, artillery positions, regions of the concentration and regrouping of troops and equipment, observing air bases of the tactical air force, and discovering systems of tactical air defense and centers for the control of the air forces. In other words, operational and tactical aerial reconnaissance is conducted in wartime and executes tasks in the interests of the units which are developing military operations in land or naval combat theaters.

The missions of strategic air and space reconnaissance are considerably wider, since they are conducted in the interests of the armed forces as a whole. US military specialists divide them into two types. The first type includes the collection of data concerning large military targets deep in the enemy rear, such as storage areas for nuclear weapons, air bases for the strategic air forces, launching positions of intercontinental ballistic rockets, the largest railroad junctions, naval bases, and military industrial centers. The other type is the obtaining of data which makes it possible to establish the intentions of the enemy, to determine the status and trend of development of his armed forces, and to discover new models of military equipment and weapons.

Strategic air and space reconnaissance is conducted by aircraft of the strategic air forces, special high-altitude aircraft of the same type as the US RB-57D, RB-57F, and U-2, specially equipped transport aircraft, drifting balloons, and, on an ever increasing scale, by means of artificial earth satellites.

Before the beginning of military operations, the main task of air and space intelligence is to disclose enemy preparations for an attack and to ascertain the priority enemy targets which must be subjected to nuclear attacks. Such targets include strategic means of nuclear attack and the most important air defense elements. The US military command, for example, assumes that for each launch crew of an intercontinental rocket, submarine crew, and carrier aircraft crew, the primary and secondary targets must be accurately determined and their characteristics and coordinates studied in advance. Obtaining information necessary for planning operations in the theater of military operations is also ascribed great importance.

main role in carrying out this task, in the opinion of foreign military specialists, belongs to intelligence devices capable of being operated in space, since the penetration of aircraft into the airspace of other states, as we have already noted above, is associated with great difficulties in peacetime.

With the beginning of military operations, the efforts of air and space reconnaissance, will presumably be switched over primarily to refinement of the position of previously detected targets for nuclear attack (in order to avoid inflicting an attack on an empty place), the ascertainment of new targets and troop groupings, and also the determination of the results of the operations of our own rockets and air forces. The number of targets, especially in a theater of military operations, may be very significant, since it is primarily the most dangerous and important of them that must be reconnoitred. For this, a large number of sorties of reconnaissance aircraft is required, and aircraft taking off to carry out other missions must also conduct reconnaissance. The distribution of tasks between aerial reconnaissance facilities is performed in the following manner. Reconnaissance aircraft of the strategic air forces conduct, as a rule, reconnaissance in the depths of the theater of military operations and beyond its limits; they ascertain chiefly strategic nuclear-rocket and aviation weapons, rocket-carrying ships, and the deep reserves of the enemy. Reconnaissance over the field of battle and in an operational depth is the responsibility of reconnaissance aircraft of the tactical air forces. The basic targets they reconnoitre are considered to be tactical rockets at launch sites and on the march, air bases of the tactical air forces, combat formations of troops and their rear echelons and communications. Space reconnaissance devices, as in peacetime, are to be used for observation of important enemy targets located deep in his rear and in theaters of military operations, and also for observations of groupings of naval forces on the seas and oceans.

The employment of various devices and types of reconnaissance in war and in an operation takes into account their strong and weak points when used together in various combinations. It is considered that together with traditional types of reconnaissance -- visual, photographic, radar, radio, and radiotechnical -- types of reconnaissance which have received limited distribution or which have never been encountered at all in the past, such as television, infrared, and radiation reconnaissance, will also be widely employed.

Visual reconnaissance. In connection with the increase speeds and flight ceilings of aircraft, effective visual reconnaissance becomes difficult, and sometimes even impossible. A crew member, carrying out visual observations from great altitudes, cannot distinquish the objects of interest to him, but in flight at low altitudes, because of the brevity of observation (because of the large angular shifts), he will be in no position to reconnoitre this object in adequate detail.

However, visual air reconnaissance is in no way excluded. In the future it will also find application, especially for the solution of operational and tactical problems over the field of battle. It will be used (at certain speeds and flight altitudes) for locating targets, controlling the results of bombing and the launchings of tactical rockets, observing the results of artillery firing, and for observing the front line and the deployment and location of tactical rocket launchers. Visual reconnaissance may be conducted by means of optical devices, making it possible to inspect the targets in greater detail. Everything that a pilot observes may be recorded on magnetic tape to prevent him from omitting any details in his report when he arrives back at his base.

Aerial photography of the terrain and targets of interest is considered to be one of the basic forms of air and space reconnaissance. Cameras for aerial reconnaissance are installed not only in all special reconnaissance aircraft of the strategic, tactical, carrier-aircraft, and army air forces, but also in the greater part of combat and transport aircraft. In recent years they have been used successfully in artificial earth satellites.

Aerial photography may be accomplished in good weather by day and by night, from high or low altitudes, and at subsonic and supersonic speeds (within certain limits). However, the altitude from which photographs may be taken is limited by the presence and altitude of cloud cover over the targets.

Night photography has a special significance, since the enemy, for purposes of hiding his intentions, will maneuver and deploy his troops and equipment chiefly during the hours of darkness. Night aerial photography with the use of special illuminating devices makes it possible to disclose these operations on time.

The illumination of targets in aerial photography at low altitudes is performed by means of illuminating cartridges (flares) fired from aircraft, and at medium and high altitudes by dropping special illuminating bombs (FOTAB, or flash bombs), which provide a flare of great intensity.

Depending upon the missions assigned and the conditions in which aerial photography is accomplished, aerial photographic apparatus of various types having different tactical and technical characteristics are used.

For vertical and oblique photography from great altitudes, as a rule, long-focus cameras are used. In the US Air Force cameras of various types are used for this purpose, and the majority of them are designed for taking photographs at subsonic flight speeds. A later modification of these cameras makes it possible to take photographs from altitudes of up to 30 km at a flight speed corresponding to Mach 2. From this altitude,

objects with linear dimensions of up to 0.6 m can be distinguished on the photographs. Photography from low altitudes, both by day and night, is performed by means of short-focus apparatuses.

Cameras intended for photography from low altitudes, and all the more so at high speeds, must have attachments and devices which compensate for the image shift. For these purposes, besides high-speed shutters of the slotted [i.e., focal-plane] or between-the-lens type, devices are used for advancing the film during exposure or for moving the objective lines, operating from signals of airborne instruments determining the flight speed.

For continuous traverse photography of a strip of the terrain from low altitudes at high flight speeds, slotted aerial cameras are used, in which the film is advanced over a narrow slot at a speed equal to the speed of the aircraft relative to the terrain being photographed.

For purposes of obtaining small-scale photographs of large regions, aerial cameras with super-wide-angle lenses are used. The US KA-52 is such a type of apparatus, which, according to statements in the foreign press, can make photographs with an angle of view of 180° from an altitude of 85 m at a flight speed of 1100 km/hr. Thus, by means of this camera and one long-focus lens rotating around the velocity vector of the aircraft, the terrain may be photographed from horizon to horizon.

Since special reconnaissance aircraft are intended for performing widely varied tasks in aerial photography, an effort is made to place as many cameras as possible in them. But their overall dimensions and weight characteristics do not always permit this. Therefore, in recent years the so-called complex aerial photoreconnaissance systems have been developed, which make it possible to solve a whole number of different tasks in aerial photography of the terrain and targets.

It is known that at the present time the US reconnaissance aircraft which are part of the armament of the tactical air command, such as the RF-48F Thunderstreak, the RF-101 Voodoo, the RB-66 Destroyer, and the naval A-3B, F-9F, and other aircraft are equipped with the "Iris" complex aerial photoreconnaissance system (or part of its apparatus).

This system, which consists of several aerial cameras, installed with various angles of inclination of their optical axes, and an apparatus for automatic processing of the exposed film, provides for aerial photography both by day and by night from low, medium, and high altitudes, in a range of speeds from 390 to 2200 km/hr. By means of it, we may obtain stereoscopic photographs of targets from altitudes of less than 150 m at speeds of 1300-1400 km/hr.

A similar complex aerial photoreconnaissance system, known as the "Wick", is installed in the Canadian CF-104 "Starfighter" reconnaissance aircraft. The system consists of four aerial cameras with independent

remote control, three of which are intended for oblique photography and one for vertical photography. This system makes it possible to accomplish photography by day and by night from high and low altitudes, automatically compensates for angular velocity, and processes the film exposed in flight.

At present, the US is also making wide use of spacecraft for aerial photography. The installation of the appropriate apparatus in artificial earth satellites placed in low-altitude orbits already makes it possible now to solve the task of aerial photography of territory and targets in any part of the globe, on the scales needed.

A special earth reconnaissance satellite, which is called the "Samos", has been developed in the US Armed Forces for purposes of aerial photography. According to information published in the foreign press, at a flight altitude of 480 km the photographic apparatus located in it, including longfocus cameras, would supposedly provide for reading of targets with linear dimensions of more than 3 m. It has also been reported that by means of the "Samos" satellite they have succeeded in obtaining photographs of the positions of intercontinental ballistic missiles, from which they could determine the nature of the positions and the arrangement of the launching pads. However, the capabilities of satellite apparatus are determined by the amount of film on board. At least two cameras are installed in the satellite, one of which, at a command from the earth, photographs a selected region in a strip 112.5 km wide, and the other simultaneously photographs the sky above, which makes it possible to determine accurately the coordinates of the regions photographed by the first camera.

It is assumed that in late models of the "Samos" satellite there are six containers each, for returning the exposed film. At a command from the earth, the containers separate from the satellite, and as they approach the dense layers of the atmosphere a parachute opens, by means of which further descent is accomplished. The descending container is recovered in the air by aircraft.

Television apparatus is occupying a place of ever increasing importance in air and space reconnaissance. It has the advantage of being able to transmit the results of the observations directly to the earth. Television cameras are installed in many types of tactical reconnaissance aircraft, and also in weather reconnaissance satellites of the "Tiros" type. However, the resolution of the television apparatus is still very low and the quality of the images does not correspond to the requirements imposed upon intelligence.

In spite of the development of improved apparatus for aerial photographic reconnaissance and television reconnaissance, it all still has one very essential shortcoming, which sharply limits its military use. The presence of fog or cloud cover over the targets hampers photography, and in certain cases entirely prevents it.

Military specialists see a partial solution of the problem of photography and observation of the targets of interest in complex meteorological conditions in the use of radiotechnical devices, such as high-capability aircraft radar sets and bomb sights.

Interest in this method of air and space reconnaissance is explained by the fact that radar sets, unlike cameras and television apparatus, are able to conduct reconnaissance in any meteorological conditions and at any time of day. But they do have a shortcoming -- the relatively low resolution, which, according to data from US specialists, is only one-four hundredth of the resolution of a camera. An increase in the resolution and range of radar sets is usually achieved by using special devices and technical methods (the pulse-compression method, multiple irradiation of the earth's surface, etc.).

In peacetime, side-looking radar sets (SLR) are of special significance in conducting reconnaissance, since they make it possible for aircraft performing reconnaissance missions to obtain a radar image of the territory to a great depth, without passing directly over the reconnaissance target. It is reported in the press that they have a number of valuable qualities; they have a high resolution with respect to angular coordinates, a constant azimuth linear resolution, regardless of the range of the target; they do not give any perspective distortions; and it is difficult to create effective countermeasures against them.

Such radar sets, which are widely used in US reconnaissance aircraft, may conduct reconnaissance in a strip from several dozen kilometers to several hundred kilometers wide. Thus, the AN/APQ-55 set is intended for conducting reconnaissance in a zone of 18-38 km with a ground speed of up to 4000 km/hr. A side-looking radar set is installed in the U-2 aircraft, providing for reconnaissance of terrain from altitudes of up to 20 km in a strip with a width of up to 450 km.

Side-looking radar sets now in the process of development have retuning transmitting and receiving systems with detectors of the linear-logarithmic type. In the opinion of specialists, such sets may be used with success in aircraft whose maximum flight speed is three times the speed of sound.

In the future, according to foreign specialists, aerospace reconnaissance by means of passive microwave radar systems, operating on the principle of fixing the radiations of targets in the radio frequency range, will become widely distributed. In comparison to active radar apparatus, they have smaller dimensions and lighter weight, do not give themselves away by radiating when in operation, and have better technical characteristics in operation in difficult meteorological conditions (for example, they make it possible to detect camouflaged objects which cannot be made out by means of active radar devices). A

passive microwave radar set is capable of detecting artificial structures with great reliability, especially metal structures. Thus, the first models of US passive radars showed a resolution of about 10 m from an altitude of 305 m. They detected structures from an altitude of 6000 m.

Apparatus operating in the millimeter wave band is also a promising means of radar reconnaissance, since it has a comparatively high resolution.

In the next few years, in the opinion of foreign specialists, we may expect the development of space reconnaissance radar systems with a resolution of 7.5 km at a range of up to 560 km, which will make it possible to compile topographic maps. For artificial satellites of the earth radar sets are being developed which must recognize large military and industrial targets from an altitude of up to 400 km. Intensive development of other types of reconnaissance radar devices is also in progress, in particular sets with a 360-degree scan, with ranges of 1600 and 2500 km, automatic tracking sets with a range of up to 1600 km, and doppler radar sets, radar altimeters, etc.

Air and space reconnaissance by means of radio and radiotechnical devices will be given the widest distribution. The development of this type of reconnaissance is predetermined by the general trend in the development of armed forces -- radiating electronic apparatus is being used and introduced more and more widely every year.

Electronic reconnaissance has the purpose of detecting and determining the position of sources of radio radiation, and also measuring the parameters of the signals received. As a result of the study and analysis of information concerning the quantity, position, technical parameters, and operating characteristics of this apparatus, the intelligence organs will obtain a concept of the state and direction of development of the armed forces.

The capabilities of airborne radio and electronic reconnaissance are very diversified and wide. By means of these methods it is possible to determine the quantity, location, and parameters of PVO radar detection and homing stations, intercept radio traffic being conducted on short-wave and VHF radio networks, observe the operation of electronic devices at rocket firing ranges and establish their nature, and most important determine methods for creating effective countermeasures against the devices being reconnoitred. Its advantage also lies in the fact that it may be conducted not only in wartime, but also in peacetime.

Among the devices used for conducting such reconnaissance, receiving devices of three types are most widely distributed: one-channel broad-band receivers, multi-channel receivers, and retunable (scanning) receivers. Receivers of the first type have the capability of faithfully reproducing the information in the signal being received. However, they have a low sensitivity and a low resolution.

Multichannel intercept receivers have greater sensitivity and a higher resolution, but the cycle required for processing the signal in them requires considerable time, which reduces their efficiency as a source of intelligence.

The scanning receiver has the best sensitivity, but also a limited rate of processing the signal received. Increases in the scanning rate and, consequently, in the processing of the signal, may be achieved only by means of reducing sensitivity.

Radio and electronic reconnaissance in the USAF is not merely collected by aircraft violating the airspace of other states. It is accomplished regularly by US aircraft making flights along the boundaries of the Soviet Union and the countries of the socialist camp. In the US press it is affirmed that a RB-47 aircraft, supplied with the appropriate equipment, apparently may, without violating the boundaries, detect the operation and position of radar sets located at a distance of 300-320 km from the frontier and determine their characteristics from an altitude of about 12,000 m.

For purposes of discovering the general radar detection system, reconnaissance aircraft use special tactical methods. While proceeding along the frontier, they suddenly change their course and proceed directly toward the frontier, creating an impression that they are going to violate it. This method is calculated, obviously, to cause the possible switching on of additional or spare radar sets, which previously were not operating.

The crews of electronic reconnaissance aircraft may also intercept secret radio communications data. Since many rocket systems are controlled by radio, they have the opportunity of detecting the launching of rockets, and also intercepting signals of preparatory operations preceding the launching. An analysis of these signals, in the opinion of US specialists, makes it possible to establish certain data concerning the design of the rocket and to ascertain whether it is a research variation or whether the launching of a military rocket is being prepared.

As a rule, an aircraft intended for conducting electronic reconnaissance has on board a whole complex of radio and radiotechnical equipment, including sensitive radio intelligence receivers, operating both in a narrow band of frequencies and in a wide band, analyzing apparatus, and devices for recording the information on magnetic tape.

The analysis and processing of data is performed on board the reconnaissance aircraft, which is, in essence, a flying laboratory. Since the volume of work performed by the crew is very great (because of the ever increasing quantity of radio and radar installations), the number of the crew aboard electronic reconnaissance aircraft, as a rule, is increased, and experienced technical specialists are included.

For conducting electronic reconnaissance, special artificial earth satellites are also used. It is known that the Tereck satellite was developed in the USA for this purpose. According to reports in the foreign press, sensitive electronic and electromagnetic apparatus is installed in it, as well as recording instruments intended for taking bearings of radar and radio signals and establishing their parameters, including instruments for recording special control and command signals transmitted at rocket test areas in the launching and control of the flight of ballistic rockets. There are also reports that the electronic apparatus for satellites of the "Foret" type was also installed and tested in the so-called research satellites of the Discoverer type.

Since existing apparatus for electronic reconnaissance has a great number of shortcomings reducing its effectiveness, designers are continuing work to improvement. In particular, intensive development of new reconnaissance receivers with frequency discriminators, with pulse compression of the electronic intelligence device, and with coding of the carrier frequency is in progress.

Receivers with frequency discriminators of the WHIP type, according to US specialists, should provide a 100-percent probability of detecting signals and determining their frequency in a wide spectrum. A receiver with pulse compression is intended for use in those cases in which simultaneous provision of a high resolution and a high scan rate is necessary. A receiver with carrier frequency coding of the type used in the "Pirate" reconnaissance system is intended for detecting new electronic reconnaissance stations and has a direction-finder device. In the US press the development of a method of electronic intelligence making it possible to determine the technical data of a radar set with an accuracy of up to 1 percent, and direction to it within 0.5°, has also been reported.

Aerial reconnaissance by means of infrared apparatus, which has a high degree of resistance to countermeasures and which makes it possible to obtain information very rapidly and to recognize targets from the spectral distribution of their radiation, is acquiring an ever greater significance. In tactical and strategic air forces, such reconnaissance is conducted for the purpose of obtaining information concerning the redeployment of troops and equipment on the field of battle in night conditions, detection and recognition of large industrial centers, cities, etc.

Infrared reconnaissance may be successfully applied at any time of the day; however, it is most effective to use it at night, when the reflection of the sun's heat from ground objects is lacking. By means of modern infrared reconnaissance apparatus, it has become possible to obtain images of the section of the terrain being reconnoitred, with a resolution of up to 30 m, at a flight altitude of 12,000 m. By 1970 the USA plans to develop an infrared apparatus providing for obtaining an image with a resolution of 27 m from an altitude of 480 km.

In recent years infrared apparatus installed in artificial earth satellites has been used for detecting the launching of intercontinental ballistic missiles. In the USA, in particular, the special reconnaissance satellite "Midas" has been developed. Its infrared scanning mirror-lens system is apparently capable of detecting the moment of launching of a rocket and tentatively determining the direction of its flight from the radiation of the flame from the rocket engine in the powered section of its trajectory. These data can be transmitted by means of telemetric apparatus to ground receiving stations for processing.

In the US press it has been indicated that in 1963, by means of the Midas satellite, the US succeeded in detecting the launchings of Atlas and Titan rockets operating on liquid propellants, and also the launchings of Minuteman rockets using solid propellants. However, in spite of certain successes, it has been established that the practical reliability of timely detection of rocket launchings by "Midas" satellites is very low. The cost of the planned system of these satellites, according to estimates, exceeds 2 or 3 billion dollars, and annual expenses for its operation would amount to not less than 100 million dollars. Considering this, the US Defense Department has decided to dispense with the initial plan for the development of a system of "Midas" satellites.

Airborne radiation monitoring has great significance in modern conditions. It is called upon to solve very important tasks in ascertaining the level of development of nuclear weapons that has been reached and the nature of experimental work in this field. By means of modern radiation monitoring apparatus, it is possible to determine with adequate accuracy, the nature and power of nuclear devices exploded at a great distance. For these purposes, highly sensitive apparatus is installed in special reconnaissance aircraft and drifting high-altitude balloons, which make it possible to detect nuclear explosions and determine their type and the power of the nuclear charge.

For the detection of nuclear explosions in space, special artificial earth satellites are used. In the USA a satellite called the Vela Hotel has been developed for these purposes. According to calculations the apparatus installed in it will be able todetect a nuclear burst with a power of 10 kilotons at a distance of up to 150,000,000 km from the earth. In 1963 two satellites of the Vela Hotel type were launched in the USA, first being placed in an elliptical orbit, and then placed in a circular orbit, with an altitude of about 100,000 km. American specialists consider that for the development of a reliable system for the detection of nuclear bursts in distant space it is necessary to have 4 to 6 such satellites permanently in orbit.

The achievements of contemporary science every day expand the technical capabilities of air and space reconnaissance devices, and the circle of their tasks is constantly expanding. As practice demonstrates, aerial reconnaissance, and especially space reconnaissance, is capable of solving a whole number of

tasks providing the elements of surprise in attack with the greatest success. [illegible], however, that the United States of America, together with its traditional forms of intelligence, is devoting more and more attention to the development of space devices. Suffice it to say that out of 150-160 US artificial earth satellites which are to be permanently located in orbit, up to 80-90 are being launched according to programs of military designation, including 20-25 specially for intelligence purposes. Also, scientific-research launchings of artificial satellites and spaceships in the USA are closely connected with military purposes and are considered as reconnoitring the future field of battle. It is well known that during the flight of the Gemini 5 spaceship at the end of August 1965, the US astronauts, according to a program from the Department of Defense of the USA, made a number of experiments of an intelligence nature: they observed targets at sea and on the ground, photographed the relief of the earth's surface, cities, ships, highways, and lakes. The crew of the ship also detected two out of three launchings of Minuteman rockets that were made specially for the purpose.

The use of a large quantity of diverse devices, operating in various regions, for air and space reconnaissance has led to a sharp increase in the flow of information arriving at the intelligence centers. The processing and study of this data and dissemination to the interested consumers is a very laborconsuming process, requiring great expenditures of time. Naturally, this causes intelligence data to become obsolescent.

The difficulties that have arisen are being overcome by means of using automation devices for collecting, processing, generalizing, and presenting intelligence information. At the present time, technical devices and automated systems have already been developed that provide for collection, primary processing of arriving information, its classification, storage, and rapid transmission to the troops and headquarters. The most complex task was the automation of the process of recognizing targets in television and photographic images. But even in this field definite progress has been made. The level of the development of science and engineering achieved have made it possible to create experimental cybernetic machines which read and make a preliminary analysis of simple intelligence photographs and television images. One of the machines of this type (the Conflex 1 system, USA) can recognize 48 different classes of images and up to 100 variations within the limits of each class.

In conclusion, we should note that an important condition of the efficiency of air and space reconnaissance is its constant mutual connection with weapons. The closer this connection is, the greater the opportunities are available for a maximum reduction of the time between detection of the target and an attack on it. And with a reduction in this time, it will be more difficult for the enemy to escape attack. The reconnaissance devices, after the target is destroyed, can be diverted to carry out other missions.

TROOP CONTROL REQUIRES A STABLE SCIENTIFIC FOUNDATION

by Col P. SHEMANSKIY

To the theory of Soviet military art a prominent position has always been given to the solution of problems dealing with the control of troops. Just in recent years our press has published a number of articles and various types of books devoted to this problem. The results of studies in the area of the control of troops have been reflected in published regulations and instructions. Important work in the training of students on the control of troops is being accomplished in military schools and academies.

However, in our opinion, all of this taken together is far from completely satisfying practical needs. In connection with the rapid rates of development of means of armed combat, the equipping of troops with the latest control equipment and the resulting changes in views on modes of military operations there are ever increasing requirements for troop control.

Under these conditions there arises an imperative need for deeper and more extensive development of scientific bases of troop control and for the publication of text books and major works encompassing the entire complex of questions on the given problem. In other words, there is required a fundamental development of a general system in our military science and military art of a special branch -- the theory of the control of troops, and also the introduction in the training program of officers of a special course on the control of troops.

V. I. Lenin long ago pointed out that any control requires special knowledge, skills, modes and methods. In order to control one must be competent, know his field completely and to the minutest detail, and have a good scientific education. V. I. Lenin constantly and steadfastly taught cadres skillful leadership and considered that for this purpose it was necessary in every way possible to develop a special science of control and to arm leadership cadres with that knowledge. Thus, in the article "Better Less, But Better," he observed that we "should pass the test on the knowledge of the bases of the theory dealing with our State apparatus, on the knowledge of the bases of the science of control." (Complete Collected Works, Vol. 45, p. 394). For this very purpose he recommended "announcing a competition on the compilation of two or more text books on the organization of work in general and especially on the work of control." (Ibid. p. 395)

V. I. Lenin devoted special attention to the scientific leadership of the army. In this respect he emphasized that "the experiment performed by the Soviet Government in military organization cannot be considered an isolated experiment. The organization of our army could lead

to successful results only because it was created in the spirit of the general [illegible] of the state of class relationships which have an effect on any type of organization." (Complete Collected Works, Vol, 40, pp. 76-77)

These brilliant instructions of V.I. Lenin on the interconnection between the military structure and the common political party are especially important to remember at the present time when the CPSU Central Committee, considering the complexity of the practical tasks to be faced in the building of communism, at its latest general assemblies made concrete decisions on problems concerning the basic improvement of control in all spheres of public life in the country. It sharply condemned subjectiveness and manifest bureaucracy on the part of leaders, and demanded a strict scientific approach to the solution of practical problems of leadership. Simultaneously in the central party press there was published a series of articles by leading Soviet scientists and specialists in which it was noted that in order to put into practice the relevant decisions of the CPSU Central Committee it was urgently necessary to revive and further develop on the basis of new conditions the science of control founded by V. I. Lenin, and also to substantially improve the training of leadership cadres in problems of the control of the national economy by means of the introduction in civilian educational institutions of a special course on control.

All of these measures of the Party directed at perfecting control also apply, without a doubt, to our Armed Forces.

The Communist party, its Leninist Central Committee and the Soviet Government constantly concern themselves about keeping the leadership of our Armed Forces always scientific and qualified. Taking into consideration the lessons of the intial period of the Great Patriotic War and postwar construction, the Party considers that subjectivism and an unscientific approach to the solution of problems in the military field are especially dangerous. In equipping troops with nuclear-rocket weapons and other new technology this subjectivism can cause even greater damage. For this reason the elaboration of bases of scientific leadership, the development and thorough study by officers of a special branch of military science and military art -- the theory of the control of troops -- are vitally necessary as they have great significance in strengthening the combat readiness of our Armed Forces.

This necessity becomes even more apparent if, in addition, the following circumstances are considered.

In the first place, as shown by history, the development of the control of troops usually lags behind the development of the methods and means of armed combat since the latter, being more flexible, are developed first and considerably faster. The degree of such lag is now directly

dependent on the organization of the scientific development of the theory of control and especially on the extent that the theory takes into consideration not only the attained level, but also the prospective development of the methods and means of fighting.

In the second place, with an inadequate scientific development of a special theory of control the only schooling in problems on the control of troops for many officers and generals was their previously acquired combat experience or postwar practical leadership in the combat training of troops. In this manner each of them traverses a long and not always correct route in attaining the maximum degree in the art of the control of troops. This route would be considerably shorter and there would be many fewer mistakes if each officer and general knew and was guided by a scientific theory of control. Here it is very important to remember the instructions of V. I. Lenin that every progressive theory does not spontaneously become the property of leaders and the masses; it is a product of science, closely connected with practical work and developed for practical work.

In the third place, at the present time generals and officers who have gone through the difficult school of the Great Patriotic War still continue to serve in our Armed Forces. However, with each passing year fewer of them remain in the army. The combat experience they acquired in the leadership of troops is, without a doubt, extremely valuable, and this experience is being transmitted to the new generation of officers in various ways and not always with sufficient skill. Quite frequently there is manifested a subjective approach to the evaluation of past events with an insufficient regard of postwar changes in the military field. The problem is that of creatively correlating already acquired experience with present conditions during the lifetime and with the active participation of those who possess that experience.

What then can be the subject matter of the theory of control of troops?

Any branch of science has its subject of research and provides first and foremost a clear concept of the main points of the phenomena and diverse processes with which it is operating, for, without their apprehension, the theoretical and practical problems confronting the given science cannot be concretely and correctly solved. From this it follows that the theory of control of troops must, in the first instance, provide a scientifically based definition of the main points and the subject matter of the very process of control of troops. This is necessitated even more by the fact that there has been no such definition to the present time despite the fact that the practice of the control of troops has a century-old history. And it is not accidental that arguments of a scholastic character sometimes take place on the subject, for example, of whether or not there is a difference between the concepts

"control of troops," "leadership of troops," "guidance of troops," "control of the means of fighting," and "control of a battle or operation."

The explanation of the main points and the subject matter of the process of the control of troops can constitute the first division of the theory under consideration.

The philosophical, legal and physiological bases of control can and should constitute its second important division. Their development at the present time is in a most neglected condition.

It is known that in an armed struggle, as in any other social phenomenon, in operation are its specific objective laws reflecting the most important connections between the individual sides of that struggle. However, these laws appear not of their own accord, but first and foremost through the activity of the command and staffs which direct the efforts of subordinate troops to the attainment of the selected objective. Consequently, the process of the control of troops is carried out under conditions of an extremely complex intertwining of the objective regularities of armed struggle with the subjective activity of command, staffs and the entire complement of troops. From this it follows that for the attainment of a genuinely scientific leadership of troops our command cadres must not only thoroughly know, but also be able to use the objective laws of armed struggle with their practical activities. However, since the revelation of these laws is not possible without the philosophical substantiations of the phenomenon of armed struggle, then their conscious application is also inconceivable without the development of philosophical bases of control.

It is also known that the control of troops is, first and foremost, the leadership of groups of persons with individual characteristics, ideologies, knowledge, habits, customs, etc. These people, in the final analysis, decide the outcome of the battle or operation, and the effectiveness of the use of means of destruction depends upon them. In a combat situation they are constantly subjected to moral danger. From them is required a tremendous effort of physical, moral and spiritual forces. Any commander exercising control of personnel frequently has to send them to certain death making use of special rights in the process, and takes upon himself a definite legal and moral responsibility before the people, the Party and the Homeland, and also before subordinates, their families and his own conscience. From every commander in combat conditions there are required great art, courage, willpower, decisiveness and self-control in order to be able to mobilize personnel for the attainment of a directed battle or operational objective, unite subordinate personnel with one common idea, and organize their combat as well as their off-duty activities, way of life, etc.

Knowledge of the principles of Marxist-Leninist philosophy, psychology and [illegible] the training and education of troops and in their leadership under combat conditions will be of inestimable help to any commander and will promote the observation of the laws and Leninist norms of leadership and the molding of troops into personnel of a new society.

In modern conditions, as a rule, the commander will have to solve problems of control in a complex, insufficiently clear, quickly changing and contradictory situation. The enemy will be striving with all possible means to mislead a commander, deceive him, force their will upon him, seize the initiative in their own hands, and also to wage so-called psychological warfare against our troops. As never before, the outcome of battle is now determined not only by force of arms, but also by the struggle of minds. These conditions require of each commander exceptionally sensible and efficient thinking, skill in the practice of using the dialectical method of analysis of contradictory facts, appearances and events, and the capability of anticipating changes in the combat situation. The development of philosophical and psychological principles of the control of troops also acquires in this case exceptionally important significance. The principles will help command personnel make the most valid decision about a battle or operation and evaluate more correctly the objective conditions of the situation taking into consideration not only material, but also moral and psychological factors. Thereby the theory of control appears as a material force making it possible to use the means of fighting more effectively and to inflict defeat upon the enemy.

The history of military art shows that with the change in the means of armed combat and the character of combat operations the control of troops has constantly become more complex as a consequence of the increased volume of control measures with the simultaneous reduction in time periods for their accomplishment. This has led to the constant increase in all armies of control agencies. However, it is presently recognized in all advanced armies that the given tendency has come into conflict with the conditions of combat operations in a nuclear missile war. Agencies and points of control have become too cumbersome, immobile and vulnerable to enemy nuclear attacks.

This contradiction can be correctly resolved only on the basis of thorough scientific research. Rash and ill-considered decisions, subjectivism and voluntarism, parochial and extremely bureaucratic interests are especially dangerous here. In the military field and in the reorganization of troop control agencies such deficiencies would be especially dangerous because they would inevitably lead to a sharp reduction in the combat readiness of troops with all the adverse consequences resulting therefrom.

In order not to permit such deficiencies and errors the theory of troop control must carefully analyze [illegible] of each agency, department and control agency at large, determine the necessity of each agency and its personnel, find a way for reduction or unification with other agencies, and also must analyze the location and sequence of distribution of control points. There is a constant need for more accurate and concrete definitions, taking into consideration new conditions, of the rights and obligations of commanders, staffs, and chiefs of arms and services in the control of troops, their interrelationship, degree of centralization of leadership and other questions which might also constitute an important division of the theory of the control of troops. All the inferred theoretical conclusions and recommendations in this area must, without fail, be carefully checked in a number of studies. Only after such thorough theoretical research and practical experiment can a start be made toward the reorganization of agencies and points of troop control, and toward bringing them into conformity with the character of modern combat operations.

A subsequent important division of the theory of the control of troops can be the development of operational-tactical requirements for the technical means of control. Presently not one commander or staff can successfully lead troops without using various technical means of control: means of reconnaissance, communications, processing of information, computer equipment, means of documenting and reflecting the situation, and various command and staff vehicles.

These means constitute characteristic material bases of modern control. They are called upon to assure rapid troop notification of a combat alert, maintenance of uninterrupted control of troops on the march and during conduct of highly maneuverable combat operations in any complex situation and especially during enemy nuclear attacks on control points, or when the latter are in movement and being subjected to strong enemy radio interference.

Technical means of control play the most important role in the fast collection and processing of information about the situation, in the production, in short periods of time, of complex operational and tactical calculations, in the formulation of the commander's decision and in the transmittal of assignments to those carrying them out. Command and staff vehicles should guarantee high mobility of control points, protection of control agency personnel from enemy fire and penetrating radiation, and also working comfort and normal rest for officers.

It is not accidental that such great attention is currently being devoted in all the leading armies to the improvement of existing and the creation of principally new technical means of control, especially special electronic computers.

However, practice [illegible] out to be unsuitable for use in a combat situation, especially if their development was based only on the present condition of combat equipment and adopted methods of waging combat operations and there was insufficient consideration of the prospects of further development of the latter. Also not excluded in deciding the question of the role of man and technology in the troop control system are errors such as the excessive urge to replace the thinking of the commander and staff officer with electronic machines. Therefore, the necessity constantly arises for implementing the development of operational-tactical requirements for means of control on the basis of achievements of modern science and technology (radioelectronics, cybernetics, mathamatics, physics, chemistry, etc) and the prospects of their development.

The control of troops also depends greatly on the methods and the style of work of commanders and staffs in the leadership of troops. New conditions of conducting highly maneuverable combat operations with the use by both sides of nuclear weapons requires an exceptionally high degree of effectiveness, accuracy and a scientific approach in that work, especially in implementing such control measures as the collection and analysis of data about the situation, making a decision and planning an operation or battle, assigning combat missions to troops, and organizing their coordination and comprehensive support. For the attainment of this theory of troop control there must be provided a thorough analysis of everything new and progressive which has been developed in the many years of experience of our commanders and staffs during the Great Patriotic War and in postwar training exercises and on this basis recommendations made for the most expedient and scientifically based operating methods for modern conditions.

In the development of these recommendations great assistance can be provided by the theory of analysis of operations and by military statistics which, it seems to us, should be concerned with the detailed analysis, rather than the simple registration, of processes of control, and on that basis to elicit the most optimal methods of solving practical problems of control, regulate flow of information, and determine scientifically based standards of management work as well as the possibility and expediency of the automation of control processes, etc. The methods of such analysis should constantly be perfected taking into consideration not only the experience of our army, but also that of the armies of other countries.

An especially wide field of activity in this area is opened to our military historians and authors of military memoirs. It would not be superfluous to remind them once again that in their works they are devoting inadmissible little attention to questions on the control of troops. At best they point out in their descriptions of the various operations where the control points of an operation were located and how

cases they do not give a clear answer on such especially important questions as the type method used by commands or commanders, staffs and chiefs of combat arms and services in the implementation of various measures for the control of troops, why in a particular operation they made one specific decision and not another, how they encountered difficulties dealing with morale and psychology and how they overcame them. As a result of this the most valuable experience of highly trained commands, commanders and personnel of control agencies remains fruitless and cannot be used for the training of young officers.

An important division of the theory of troop control should be the method of educating the officer corps and training them in problems of control. Here also there should be no stopping with already achieved results. Progressive training experience specifically indicates that the working out of problems of control should not be limited to only "incidental work" along with the solution of problems in the combat application of arms and special troops because this inevitably leads to superficial and fragmentary knowledge and skills of officers. Experience shows the expediency of having a special course on the control of troops in the system of command training both in troop schools and in military educational institutions. The subject matter of this course can include the same problems considered in the theory of troop control. The method described below can be used as a guide for the conduct or development of such a course.

In conformity with the program of the course on operational art and tactics officers can study general laws and principles of armed combat and problems of the combat employment in an operation or battle of various combat arms and special troops: their purpose, composition, organization, combat capabilities, missions, combat formations, methods of operation, etc.

Simultaneously or parallel with this there is developed a course on the control of troops encompassing the previously stated general theoretical bases of control and the structure of control points and agencies - and agencies acquire elementary practical skills in the accomplishment of concrete measures in the control of a given type of operation or battle and in various conditions of a situation. Following this at group exercises, briefings, military games, command-staff and troop training exercises officers completely work out both courses, taking them individually as as interrelated units; that is, they acquire skills both in the combat application of arms and special troops and in the practical work of the corresponding commanders, staff officers and chiefs of combat arms and services in a specific combat situation.

In such a method of training there is the greatest possible observation of the principle of transition from the simple to the complex and

from the [illegible] increased and improved more effectively; and there is a broader use of various technical means of control which are used not only during field exercises, but also in the conduct of classroom exercises. In conjunction with this there is the possibility of conducting the training in a more instructive manner than in the past when instructors and pupils sat behind bare desks and worked on maps which were the only itmes used for working out problems in the control of troops. In addition, situation data or problems quite frequently were presented not as they occurr in actual combat, but extemporaneously, on a huge plotted chart or map, or in the form of a voluminous written document, etc. The activites of students during exercises involving reports of the situation, assignment of missions to subordinates, informing neighboring units, etc., were also frequently reduced to normal conversations about such activities with the instructor. Such a method of training has become outdated. It does not conform to the elementary requirements of teaching and especially to the requirements of the principle of unity of theory and practice. It inevitably creates in the students a false notion about time factors and other conditions of leadership of troops in a battle or operation involving the use of nuclear weapons.

Experience demanded that the majority of practical exercises conducted before going out into the field be transferred from unequipped classrooms to laboratories equipped with various technical means of control. These laboratories, in the main, are a type of training apparatus or models of corresponding control points. Calculations show that expenditures for their equipment are repaid with interest. In addition, there is a considerable saving of resources since, in this case, there is no longer a requirement for working out each problem in the field several times.

A new organization of the method of giving officers oral examinations and tests on problems in the control of troops would also be highly expedient. At these examinations and tests officers should not only answer theoretical questions, but also complete various practical assignments: receive data on the situation from various sources using communications equipment; plot the situation on a map; report conclusions based on the evaluation of the situation; make operational and tactical calculations using computer equipment; assign missions to troops using various methods; etc. Such a method promotes the consolidation of theoretical knowledge and the development of sound practical skills in the control of troops. Together with this it places a greater demand on officers to devote attention to systematic independent work on self-improvement in perfecting skills in control by means of training work in laboratories without limiting themselves to working out problems of control only during planned classes and training exercises.

The research on these problems [illegible] officers in the area of control should also occupy itself with the presented theory of the control of troops.

Finally, problems of military administration can constitute a rather important division of the theory of the control of troops. Their scientific resolution makes it possible to improve the selection and placement of military personnel, the organization of troops, the completion of administrative work, and the solution of other problems. From the foregoing it is evident that the theory of the control of troops does not appear to us to be something abstract, isolated, cut off from reality. It is a highly concrete, extensive and important area for special research. In military art it is an integral part or branch of strategy, operational art and tactics, closely connected with still another part -- the application in an operation or battle of branches of the armed forces, combat arms and special troops, and also with other sciences. Marxism-Leninism serves as its basis.

Thus, the subject matter and the object of investigation in the theory of the control of troops can be: the essence of control and the demands made against it; philosophical, psychological and legal bases of control; the structure of control points and agencies and their technical equipment; theoretical bases, principles, tactical methods and the style of work of commanders and control agencies in the leadership of troops both in peacetime and wartime; the method of training commanders and control agencies in the accomplishment of their functional obligations in the leadership of troops; and problems of military administration.

The centers for the development of the bases of such a theory are our leading military academies and all officers of the Armed Forces can participate in this work. The latest decisions of the CPSU Central Committee have opened up for them a well marked road in the development of science and have established conditions for creative work.

Supported on the stable foundation of Marxism-Leninsim, the experience of the CPSU Central Committee and the Soviet Government in the leadership of the national economy, the combat experience of past wars and postwar training exercises, and also taking into account modern achievements and the prospects of the further development of military and other sciences, they have every possibility for the successful solution of the problems under consideration.

The basic means for the development and establishment of a new theory of control, from our viewpoint, will be the conduct of the following: thorough theoretical investigations in the area of control based on analysis of experience; accomplishment of experimental work in laboratories and with officers during training exercises; verification of

especially troop training exercises conducted under the most varied conditions and approximating those of combat to the maximum extent; extensive discussion and definitive correlation of results of investigations; development and publication of fundamental scientific works, textbooks, training manuals, regulations, instructions, guides, articles, etc.; and also drawing up practical recommendations for the improvement of systems of control points and agencies and their technical equipment.

Thus, purposeful and thorough scientific investigation in the area of control and the detailed development of the general system of the military science of the theory of control constitute one of the most important conditions for the attainment of a genuine scientific leadership of troops, and for bringing that control into complete conformity with the present methods and means of armed combat and with the prospects of future development.