TOP SECRET RUFF TRINE

2 JUN 1966

MEMORANDUM FOR: CIA Director of Reconnaissance

SUBJECT : Soviet Public Statements on US and USSR Space Technology Since 1962

1. Our examination of recent press articles and public statements by Soviet officials reveals that these sources do not contain useful detail on Soviet space reconnaissance technology and generally avoid direct acknowledgement even of Soviet activity in this field. There have been a relatively few public and semi-public official admissions that the USSR either has engaged in, or is capable of, space reconnaissance over the US. Even in these cases, however, no claims have been noted with respect to the technical capabilities of the Soviet systems; to the extent of Soviet reconnaissance programs; or to the importance of satellite photography to Soviet defense planning. On a few occasions Soviet statements on US space reconnaissance have occurred in a context in which there are slight inferences that Soviet programs enjoy a degree of parallelism in purpose and technology with US programs, but such cases probably should not be construed as claims to technological comparability.

2. Soviet public statements about US space reconnaissance programs, on the other hand, have been considerably more direct and specific. Technical characteristics -- of vehicle, orbit, system resolution, and targets -- have been attributed directly to US space reconnaissance satellites. Such statements have not, however, been presented in carefully measured scientific terminology. They appear to be designed to provide only approximations of technological capability -- largely in terms of resolution -- rather than to rigorously describe the types of system components that would provide the results claimed.

3. Information in Soviet overt materials on capabilities and purposes of US systems seems to be derived from a careful screening of articles and statements appearing in US newspapers and non-scientific journals. Typically, a direct attribution to a US or European source also appears in the Soviet statement. We have seen

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no occasion of a public Soviet statement that appeared to be based on a careful technical analysis of US scientific or engineering data that is either openly available to the USSR or that may have been procured clandestinely.

4. The materials reflect no abrupt changes in treatment of the subject during the period examined. The later materials, however, tend to reveal more data on US technology and are more comparable with information contained in the earlier Ironbark series. The second edition (1963) of Marshal Sokolovskiy's book, Military Strategy, for example, added technical details not given in the 1962 version. In a new passage noting the dependence of the US counterforce strategy on reliable reconnaissance systems, Sokolovskiy cited a US estimate of a possible ground resolution of 2 meters with satellite photography. By August 1964 RED STAR reported that the Samos satellite provided a resolution of 0.75 meters, permitting photography at 500 kilometers altitude. The restricted journal MILITARY THOUGHT in October 1965 went furthest in describing technical specifications of the Samos camera system and the parachute recovery of the "assumed" six containers of film. This source stated that the resolution qualities of the Samos systems "supposedly" provide for reading targets "more than 3 meters in size."

5. Through the device of reviewing US press commentaries and speeches by US leaders, Soviet publications have managed increasingly to enumerate the technical requirements for instrumented space reconnaissance systems, though not in a high degree of detail. The multiplicity of US programs and systematic target coverage are emphasized. The types of targets being pinpointed have been repeatedly described as including Soviet industrial areas, ICBM launch sites, airfields, naval bases and troop concentrations. Use by the US of infrared and electronic collection systems has also been acknowledged.

6. Only minor differences are evident among the various types of publications examined. The central newspapers such as PRAVDA and IZVESTIYA and the radio broadcast material pay greatest attention to propagandistic slants. Public statements in these media have almost

invariably cited the peaceful purposes of Soviet space programs, which they contrast with US efforts. Satellite surveillance has been consistently defined as a military use of space. The military press, while offering its professional military readership a more balanced presentation, places more stress on the threat implicit in U.S. reconnaissance capabilities. A highly proficient and reliable space reconnaissance system is listed as one of the essential elements of the U.S. flexible response policy by one prominent military strategist. The scientific press apparently refrains from treatment of any aspects of the subject.

7. Some examples of Soviet writings about U.S. reconnaissance technology are appended in two tabs to this memorandum. Tab A consists of a listing of selected short Soviet comments on the subject, arranged chronologically. Tab B is a full translation of a longer article from the October 65 issue of the Soviet journal Military Thought. In this article the authors discuss the role of both airborne and space reconnaissance systems in military operations and provide some discussion of the technology of US systems. A much greater wealth of detail is provided on the technology of present US airborne systems than on space systems in this article -- an emphasis which suggests that the USSR is reluctant to admit publicly to too great a knowledge of the technology of US space reconnaissance systems.

R. J. Smith

R. J. SMITH
Deputy Director for Intelligence

Attachment:

TAB A: Chronological Listing of Selected Soviet Comments on Technology of US Space Reconnaissance Satellites
TAB B: Air and Space Reconnaissance in Armed Conflict

TAB A: Chronological Listing of Selected Soviet Comments on Technology of US Space Reconnaissance Satellites

1. January, 1963

"Midas is intended to detect the launching of ballistic rockets, Transit is to provide rocket-carrying submarines with navigational data, and Samos is a satellite containing a photographic laboratory. The US specialists place great hopes in the system of Samos satellites because this is, in effect, a system of space espionage intended to replace the discredited U-2 aircraft. By photographing the earth the militarists intend to gather data which interest them on military objectives situated on the territory of the Soviet Union and other countries. The press notes that the next variants of the Samos will be equipped with infared and radar equipment, making it possible to obtain pictures of the surface of the earth through clouds and at night." (Cols. V. Glazov and V. Vaneyev, RED STAR 19 Jan 63)

2. Mid-1963

"The military command of the US intends to solve the reconnaissance problem /inherent in the new counterforce strategy/ primarily by launching a large number of special reconnaissance satellites. According to its estimate such satellites, located in space, are capable of photographing objects with a size of two meters and, in the period 1965-1970 possibly, will be able to photograph at night objects 60 centimeters in height from an altitude of about 500 kilometers. (Marshal V. D. Sokolovskiy, ed., MILITARY STRATEGY, second edition, 1963. This passage did not appear in the first edition, 1962.)

3. March, 1964

"Why is America launching such artificial satellites as Samos, Midas, and others with reconnaissance equipment aboard? These are purely military satellites, in the center of attention of US military programs. Even in America these satellites are called 'spies in the sky.' At present, work is under way to create a system of Midas satellites. When this program is implemented, American specialists assert, all areas of the earth will be under continuous surveillance." (Col. G. Terent'yev, RED STAR 26 Mar 64)

4. June, 1964

"Aggressive circles in the imperialist camp regard outer space as an arena of future military operations. They want to

place the achievements of astronauts in the service of devastating thermonuclear war. The launching of secret espionage satellites, projects of various systems of space attack, and many other measures taken by the imperialist circles are the elements of their aggressive policy. The Soviet Union, on the contrary, is a consistent advocate of international cooperation in using outer space for peaceful purposes. (Marshal Vershinin, PRAVDA 14 Jun 64)

5. July, 1964

"Premier Khurshchev delivered an emphatic warning today against any further US reconnaissance flights over Cuba... Mr. Khrushchev added that the flights were unnecessary in view of the success of camera-equipped satellites." (NEW YORK TIMES 1 Jul 64)

6. August, 1964

"The testing of the /Conflex/ machine is continuing. The goal is to achieve precise analysis of all possible air reconnaissance photographs which contain already known configurations of images of military equipment and military installations. The creation of even more improved machines opens up amazing prospects for using them in military affairs. The rapid and precise deciphering of aerial photographs is a very important problem for foreign military specialists at present... In the US it has been calculated that they must gather reconnaissance data on the territories of countries having an area of more than 41 million square kilometers, and for this they must decipher 180 million photographs." (Engr-Col. M. Goncharenko, SOVIET PATRIOT 16 Aug 64)

7. August, 1964

"The focal length of the cameras aboard the Samos satellites reaches 3 meters and the resolving power is 0.75 meters. This makes it possible to obtain rather clear images from an altitude of up to 500 km. To avoid smudging of the image due to the movement of the satellite, the cameras are equipped with a central specially designed shutter and an optical compensator, and the film is covered with a special emulsion. The process of developing the film on the satellite has been fully automated. On board there is also a radio-electronic command device for turning on the cameras over the required points of the earth... Capsules are dropped by the satellite upon command from the earth, and fall to a fixed altitude on parachutes... In the opinion of American specialists the resolution of the space cameras is still insufficient. They feel it essential that they produce a clear image of objects having a linear dimension of 0.6 meters. (Engr-Lt. N. Ilin, RED STAR 29 Aug 64)

8. January, 1965

"The US military command devotes the greatest attention to the organization of space reconnaissance. With the help of these new means it intends now, in peacetime, to determine the coordinates of military industrial targets, launching sites of intercontinental ballistic rockets and rockets of intermediate range, airfields of strategic aviation, naval bases, large troop concentrations, and other very important military targets... Satellites of the Samos type have been acquired by US armament as a means of reconnaissance. Launches of experimental and test models of these satellites have been systematically executed since 1960... Declarations on the high qualities and complete readiness of the Samos system are in conflict with other reports which say that work on the completion of this system is proceeding at full speed. When this system is fully completed, it is supposed to consist of six to nine satellites which will make it possible to photograph the earth's surface in 20 days." (Col. V. Glazov, RED STAR 26 Jan 65)

9. August, 1965

"The Gemini program also envisages tests as to the possibility of using spaceships for strategic reconnaissance from the Cosmos. It will carry on board cameras with long focal length lenses which can take detailed pictures of towns, railroads, ports, ships, and other objects. In addition the cosmonauts will perform visual reconnaissance. The spaceship will fly 11 times over Cuba, 17 times over the DRV, and 40 times over the CPR. According to the Washington EVENING STAR, Gemini 5 has a great quantity of reconnaissance equipment aboard." (Engr-Maj. I. Vershchagin, RED STAR 25 Aug 65)

10. September, 1965

"From their spaceships American astronauts are in a position to conduct visual reconnaissance, to photograph terrain and conduct surveillance by means of infared and other instruments. US space spying is assuming an ever wider and threatening scope. Dozens of different automatic spy stations are continually in orbit. From unmanned satellites, surveillance is shifting to manned space laboratories." (Col. Gen. V. Tolubko, LIFE ABROAD, No. 37, Sep 65)

11. September, 1965

"Two years ago, two types of Samos reconnaissance satellites, heavy and light, were commissioned for armament. Their tasks are

photo and radio reconnaissance. The light satellites are launched for 'gross' photography and they give small-scale pictures of localities. In addition, heavy satellites with a weight of up to 2 tons and with more perfect photo equipment are being launched. They make it possible to discern on the territory of the likely enemy, that is, the Soviet Union and other socialist countries, various objects with a linear size of 16 to 20 meters. The special equipment of such a satellite can work for 30 days and nights."

"Samos is also used for radiotechnical reconnaissance -- for the location of electromagnetic emenations of various origins and for intercepting information passed along radio communication lines. The Pentagon wants to know the location of rocket-launching positions, strategic airfields, the bases of ships and submarines, construction sites for military installations, and what is in the air over various countries. For this purpose scores of Samos satellites have been launched into space."

"These 'heavenly spies' are far from always rendering the required results. The press reports continually of the poor quality of the pictures obtained, of the restricted possibilities of taking pictures -- only during the day from a cloudless sky, and so forth. In addition, the store of films is so small that the satellites rapidly become useless." (Col. M. Golyshev, IZVESTIYA 28 Sep 65)

12. October, 1965

"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 bassistic 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." (Cols. B. Aleksandrov and A. Yur'yev, "Air and Space Reconnaissance in Armed Conflict, MILITARY THOUGHT, No. 10, Oct 65, FOR OFFICIAL USE ONLY)

13. November, 1965

"Samos, Midas, Ferret -- these are the names of some representatives of this family of spy satellites hurled into space by the Pentagon. Their assignment: military reconnaissance with cameras and infrared rays, and interception of information transmitted by radio communications. An even better job, in the words of the author of the article /in US News and World Report/ could be done by military satellites with a man on board. Gemini 5, he said, helped to demonstrate that it is possible to conduct military operations in space if the country wishes to spend time, money and resources." (G. Vasin, KOMSOMOL PRAVDA 4 Nov 65)

14. April, 1966

"The development of reconnaissance satellites began in the US as early as 1959 on the basis of the Discoverer program. These devices were given various names -- Pied Piper, Sentry, Big Brother, and finally Samos, which is called by the Americans themselves the 'spy in the sky.' Defense Secretary McNamara announced that existing plans envisage an annual launching of 12 to 20 such satellites." (Maj. Gen. Avn. Ret. B. Teplinskiy, RED STAR 23 Apr 66)

TAB B: AIR AND SPACE RECONNAISSANCE IN ARMED CONFLICT

by Cols B. ALEKSANDROV and A. YUR'YEV

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.

All these advantages advanced aerial reconnaissance to one of the 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 in carrying out missions, 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 significance. The

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 Ferret 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 "Ferret" 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 the 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 to detect 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. It is possible, therefore, 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.