24 JANUARY 1980 (FOUO 3/80) 1 OF 1

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24 January 1980

USSR Report

MILITARY AFFAIRS

(FOUO 3/80)

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CONTENTS PAGE

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CONTENTS OF 'FOREIGN MILITARY REVIEW'

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 1-2

[Indicated in the table of contents below are the full text translations (*) and the excerpted translations (**) which will be published in this series and a full text translation (***) which will be published in the JPRS FOUO series of the CHINA REPORT: POLITICAL, SOCIOLOGICAL AND MILITARY AFFAIRS.]

[Text] CONTENTS

6904
CSO: 1801

COMMUNICATIONS: SOVIET REVIEW OF U.S. DEFENSE SYSTEM

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 14-17

[Article by Col B. Yushakov: "U.S. Defense Department Joint Communications System"]

[Excerpts] The Pentagon is placing reliance on waging war using mass destruction weapons and is attempting to create a system for control of staffs and troops scattered across the entire globe which would permit providing to them orders and instructions for unleashing aggressive actions or shifting them to a higher degree of combat readiness in short periods of time (practically in real time). The primary problem here is considered to be the increase in survivability, reliability and flexibility of control of the armed forces on the part of the supreme national military-political leadership.

An important role in resolving this problem is given to communications forces and facilities, and primarily those belonging to the joint communications system of the U.S. Defense Department, the DCS (Defense Communications System), which takes in practically all points on the globe where American headquarters and troops are located. It is primarily intended for providing communications for the supreme national military-political leadership (the president, secretary of defense and chairman of the Joint Chiefs of Staff), joint and special commands, and the main directorates of the Defense Department. As reported by the foreign press, 15-20 percent of DCS channels are used in the interests of a global system of operational control, while some of them are assigned for transmission of intelligence and data on an enemy nuclear missile attack.

The DCS system makes wide use of all the primary forms of communications: radio, radio-relay, tropospheric, wire, cable and satellite. The Defense Communications Agency is responsible for its organization and normal functioning.

Zonal communications agencies also have been set up at the headquarters of main command elements of U.S. Armed Forces in Europe, in the Pacific, and with the joint North American Air Defense Command (NORAD) for providing instructions of the military leadership more rapidly. Several regional divisions are subordinate to each of them. Their primary mission is to provide reliable and uninterrupted operation of communications systems and facilities in their own "zones (regions) of responsibility." The operations center of the Defense Communications Agency exercises immediate control through operations centers of zonal communications agencies and regional communications divisions.

There are over 130 primary and alternate relay centers in the DCS, some of which are outfitted with automatic switching gear. The overall length of cable, wire, radio-relay, tropospheric and satellite communications lines is 67 million channel-kilometers. They connect over 3,000 control points scattered across the entire globe.

The foreign press emphasizes that the aggressive war of the United States in Vietnam, where a number of essential shortcomings were revealed, served as impetus for accelerated development of communications in the higher echelon of command and control of the armed forces. The national military-political leadership demanded that the Pentagon achieve that operating status of communications systems and facilities in which data would pass from top to bottom and vice versa in real time or near real time. Foreign specialists identify the following important directions in development of U.S. communications systems in recent years: a broad introduction of new satellite systems (military and leased from other departments), special DV [long wave] and SDV [ultra-long wave] communications systems and encipherment gear; further automation of digital communications systems; and an increase in their noise stability.

The primary components of the presently existing DCS are the AUTOVON, AUTODIN, and AUTOSEVOCOM automated communications systems and the DSCS-2 strategic satellite communications system. In addition, the DCS includes long-range communications centers and equipment belonging to branches of the Armed Forces and channels leased from private companies by the Defense Department.

In 1978 there were up to 150 different control points among the system's subscribers, of which around 40 were part of the GSOU [global operational control system], 20 in the Navy and the rest in the Army, Air Force and Marines.

At the present time the system is in the next phase of development (DSCS-3), which will last until 1982. When it is fully deployed, four primary earth satellites and two alternate satellites are to be activated as a space element. The operating frequency range is 7-8 GHz. Each satellite provides communications over four trunks (1,300 telephone channels each). In case the American satellites are disabled, the system can operate through communications satellites of the NATO and British systems.

Around 500 ground terminal stations will be deployed by 1982, when it is planned to place this system in operation. Of these, 80 will be part of GSOU, 40-50 for the Navy, 300 for the Army, Air Force and Marines, and the rest for the Diplomatic Service.

Other satellite communications systems functioning in the interests of the Defense Department's DCS are the AFSATCOM and FLTSATCOM. In contrast to the DSCS, they operate in the 225-400 MHz band and have considerably fewer channels (several dozen).

The foreign press emphasizes that the U.S. Defense Department joint communications system basically supports the needs of the armed forces and the supreme national military-political leadership even at the present time. With the final introduction of the AFSATCOM and FLTSATCOM satellite systems, the capabilities will expand considerably, especially with regard to instructions provided to strategic offensive forces.

In the assessment of American military specialists, the presence of several global, autonomous communications systems considerably increases the survivability, reliability and flexibility of the armed forces command and control system or its individual components and permits providing the necessary instructions and directions of the supreme military command to headquarters (control points of separate commands) and large and small units in real time or near real time.

All this shows once again that the forces of imperialism are preparing actively to conduct war in different parts of the world.

6904
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NUCLEAR WEAPONS: SOVIET REVIEW OF U.S. STORAGE FACILITIES

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 18-20

[Article by Col Ye. Fokin: "Security of Nuclear Weapons Storage Facilities"]

[Text] Militaristic circles in the West are unwinding the arms race spiral more and more strongly. Appropriations for military purposes grow with each passing year, the development of military sectors of industry is being forced, and stockpiles of mass destruction weapons are building up. According to estimates by foreign military specialists, there already are over 30,000 weapons in the U.S. nuclear arsenal, of which around 7,000 are located in the zone of the aggressive NATO bloc in Europe and over 1,000 at American military bases in the Pacific area. There are tentatively up to 1,500 different installations for the storage and accommodation of American nuclear weapons in various parts of the globe, of which over 100 are in Europe and around 130 on U.S. territory (Fig. 1) [Figure not reproduced].

Broad layers of world public opinion, including American public opinion, are being alarmed by the scorn shown by militarists of the United States and NATO allies toward demands for banning the production and stockpiling of mass destruction weapons. Facts of the recent past indicate that the irresponsible attitude toward such problems abroad more than once has threatened the lives of many thousands of people. For example, that was the case in 1966 in Spain and in 1968 in Greenland, when strategic B-52 bombers with nuclear bombs aboard suffered catastrophes over their territories. In the estimate of foreign observers, the total number of such instances is over ten.

The foreign press reported results of a 1973 check of the status of security of American nuclear weapons storage facilities in Europe. The official report of the inspection group sent to the U.S. Secretary of Defense stated that some of them did not have the appropriate security, were kept in poorly equipped facilities and, in addition, requirements of the checkpoint conditions and rules for security of the facilities were violated.

According to the western press, in recent years the Pentagon allegedly has conducted a number of measures to beef up security of nuclear weapons. In particular, military storehouses for special kinds of weapons are being outfitted with special security equipment. It was reported that at the present time such equipment has been installed in 50 Air Force installations, including nuclear weapons storage facilities, air bases for B-52 strategic bombers, and airfields for American tactical air duty subunits located in Europe and the Pacific. In addition, in 1980 it is planned to outfit still another 50 installations with more sophisticated security equipment, and in 1982 to begin deploying an automated security system being developed under the BISS (Base and Installation Security System) program. It represents a sophisticated electronic system which includes an electronic computer, security signalling devices, television and illumination equipment, employee identification instruments (Fig. 2) [Figure not reproduced] and so on. The composition and accommodation of this system at a nuclear weapons storage facility is shown in Fig. 3 [Figure not reproduced].

Along with the introduction of this equipment, the U.S. Defense Department planned the reorganization of the nuclear weapons storage facility security service in 1978-1979 and a simultaneous increase in the size of its units to 20,000 persons, providing them with more sophisticated small arms, armored vests and other gear.

By carrying out these measures, the American command is attempting to prevent a sudden surprise seizure of nuclear weapons by the enemy in case of war or by extremist groups of terrorists in peacetime.

As noted in the foreign press, stores of special shaped charges of high explosives intended for rapid destruction of weapons have been supplied to all American nuclear weapons storage facilities in Europe. According to a Defense Department directive, around 1 hour is given for destruction of 25-30 nuclear weapons located in one fixed storage facility.

Western military specialists believe that outfitting nuclear weapons with coded security devices known as PAL (Permissive Action Link), intended for preventing unauthorized detonation, is one further step in increasing the security of American nuclear weapons. This ensures relatively reliable interlocking of the weapon's main electrical circuits, which can be removed only by two American service personnel authorized to do this, acting in sequence and separately from each other. Another variety of this device is used in some types of munitions, the unlocking of which is done prior to combat use also by two specialists by dialing a prearranged digital combination on a locking device.

In addition, measures are being taken under a program for checking the reliability of persons working with nuclear weapons. According to foreign press data, considerable contingents of military and civilian specialists are brought in for servicing American nuclear weapons. They undergo a check both before entering service and periodically while performing service. If a specialist does not meet the demands placed on the state of health, conduct, social origins or political views, he is not authorized to work on these objects.

According to 1972 data, around 14,000 persons were used for various types of work with nuclear weapons in the American ground forces in Europe. During the year 213 of them were disqualified for reason of neuropsychological illnesses, abuse of drugs and alcohol, and for poor performance of official duties, disciplinary infractions and amoral conduct.

The western press notes that measures being conducted in the United States for the security of nuclear weapons also touch on the sphere of production and stockpiling of special fission materials (plutonium-239, uranium-235 and uranium-233). According to the assessment of foreign specialists, there is an annual loss of approximately 25 kg of plutonium and 45 kg of uranium in the United States because of deficiencies in record keeping, supervision and storage. The possibility is not precluded that such materials will get abroad or will fall into the hands of criminal terrorist groups.

In the estimate of foreign scientists and specialists, persons having the necessary supplies and connections can prepare their own nuclear weapon from the aforementioned radioactive substances (termed a "homemade" or "crude" bomb in the United States) and in the absence of such conditions can use it for subversive purposes.

The U.S. Defense Department together with the Department of Energy is carrying out a number of supplementary measures to close the channels for loss of fission materials. In particular, they include creation of a special bureau for security of fissionable materials under the Energy Department's Commission on Nuclear Security and Licenses, and the participation of the FBI and CIA in their security and investigation.

In assessing the measures being conducted by the U.S. military department to secure special types of weapons, the foreign press notes that no matter how sophisticated the means being developed, they will not ensure reliable protection of persons against possible chance happenings. Only cessation of the production of nuclear weapons, a subsequent cut-back in stockpiles and complete elimination of the stockpiles are the real ways for assuring international security and stable peace. The Soviet Union and other countries of the socialist community repeatedly have pointed this out.

PHOTO CAPTIONS

1. p. 18. Fig. 1. Diagram of location on U.S. territory of facilities intended for the development, production and storage of nuclear weapons and special fission materials, from the journal BULLETIN OF ATOMIC SCIENTISTS.

2. p. 19. Fig. 2. Checking employees arriving at a nuclear weapons storage facility by comparing fingerprints, from the journal INTERNATIONAL DEFENSE REVIEW.

3. p. 19. Fig. 3. Nuclear weapons storage facility equipped with the BISS automated security system, from the journal INTERNATIONAL DEFENSE REVIEW.

6904
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NATO: SOVIET REVIEW OF LAND MINE SYSTEMS

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 32-35

[Article by Col (Res) N. Zhukov: "Remote Mining Systems of NATO Armies"]

[Text] Active work continues in armies of the leading countries participating in the aggressive NATO bloc to create new types of weapons and combat equipment. Much attention is being given to antitank weapons. Foreign military specialists consider the wide use of minefields laid on probable routes of enemy movement to be very important and effective for maximum limitation to the mobility of highly mobile enemy units.

Methods for laying minefields which existed up to the present time were very laborious and required a large number of mines and minelaying equipment. In this connection, foreign specialists performed research for a long while to develop new mining systems. As a result they succeeded in creating qualitatively new equipment which allowed a sharp reduction in laboriousness of work, a decrease in the expenditure of mines and a reduction of time for laying minefields.

The creation of new antitank mines differing substantially from mines of the old, classic type by reduced weight and size (without reduction in the efficacy by using a charge with a special directional-action shape) also contributed to the solution to this problem. The new mines are equipped with an electronic (influence firing or contact-firing) fuse and are capable of functioning under the entire projection of the tank. Because of their small size, these mines are difficult to detect visually and so can be scattered on the surface of the ground.

The most effective means for laying mines have been developed simultaneously with the new mines in NATO armies. The small dimensions and use of high-strength, eliably operating electronic and mechanical components permitted the creati. : of mines capable of withstanding very heavy loads. As a result, use began to be made not only of ground minelayers which scatter mines to distances of several tens of meters, but also artillery, missile and air systems. The new equipment, which is designated "remote mining systems," are becoming more and more widespread at the present time in the armed forces of leading NATO countries.

As noted in the foreign press, these systems should substantially increase troop capabilities for high-speed laying of minefields. It is emphasized that remote minelaying equipment at the commander's disposal allows him to make more flexible and active use of them during a battle not only on the defensive, but also in the offensive. Special attention is given to the fact that, thanks to the extremely compressed time periods for laying obstacles using these systems, there is no longer need for minelaying ahead of time, which usually tied one down previously to terrain conditions (such as mining sectors accessible to tanks).

In addition, the remote mining method permits laying mines directly ahead of a moving enemy or directly on his combat formations. Foreign specialists emphasize that this means that the new minelaying equipment permits action against a specific enemy, which should ensure greater effect through the element of surprise.

The first models of remote minelaying systems already have been accepted into the inventory of some NATO armies, while a considerable number of systems are in the concluding phase of development, which should be completed in the next two or three years.

The basis of remote mining systems in the United States are antitank and antipersonnel mines being developed under a program for creating a family of remotely laid mines known as FASCAM (Family of Scatterable Mines), and intended for laying by means of ground-based minelayers, tube and rocket artillery, and aircraft. According to American press reports, the mines of this family are characterized by compactness, light weight, and the presence of a self-destruct device by which they self-destruct after a given period of time after being laid on the terrain so as not to hinder the maneuver of friendly forces, and an antidisturbance device which initiates the mine when there is an attempt to move it from its place. American specialists have developed several models of mines which differ slightly among themselves chiefly by the minelaying equipment.

The GEMSS (Ground Emplaced Mine Scattering System) is considered to be general-purpose. It is intended for laying the XM75 antitank mines and the XM74 antipersonnel mines using the XM128 towed minelayer towed by the M113A1 tracked APC or a 5-ton truck. The XM128 (Fig. 1) [Figure not reproduced], produced on a modified M794 double-axle trailer, consists of two interchangeable cylindrical cassettes loaded with mines and a launcher, by which the mines are thrown from a rail to the sides a distance of a few tens of meters. As the minelayer moves, mines are scattered in a strip of a given width. The density of the minefield being laid is determined by the speed of the prime mover and rate of mine ejection, which can change within the range of one to four mines per second. The capacity of one load is 800 mines. It is planned to complete development of this mining system in 1979.

The RAAMS (Remote Artillery Antitank Mine System) and ADAM (Area Denial Artillery Munition) antipersonnel system are representatives of artillery minelaying systems. Both of them are intended for use by authorized 155-mm howitzers (the M109A1 self-propelled and the M198 towed howitzer), the unit of fire of which includes cassette rounds with mines. These rounds are produced in the M483 standardized casing and have a common M577 point aerial-burst fuse. The ammunition enumerated below have been taken into the inventory and are in mass production.

The M718 and M741 rounds, which contain nine M70 and M-73 mines each respectively, are used in the RAAMS antitank mine system. The round's M577 point aerial-burst fuse is activated on a given leg of the trajectory and the mines contained in it are ejected, drop in the necessary area and are automatically armed after a given time. The mining area when firing a salvo from 12 pieces is 350x250 m. The M629 and M731 rounds are used in the ADAM antipersonnel system. Each of them contains 36 M67 and M72 antipersonnel, fragmentation-type bounding mines each respectively. After falling to the ground, the mines are armed after thin trip wire-sensors are thrown from their casings to the sides with the help of springs. The mines detonate when one of the wires is touched by a person moving by.

The SLU-MINE (Surface Launch Unit-Mine) missile mining system is being created for the engineer troops and is intended for rapid laying of antitank mines. It is a self-propelled, 30-tube launcher similar to that used for clearing minefields (the SLU-FAE mineclearing system[1]). Using it, it will be possible to lay minefields at a distance up to 5 km within extremely compressed time periods. The duration of a full launcher salvo is around 15 seconds. Firing will be by a NUR [free-flight rocket] with cassette warheads equipped with the M70 tank-killing mines. The projectile's payload opens up at a given point in its flight trajectory, the mines drop to the ground and are armed after a certain time interval. Minelaying can be done immediately in front of moving enemy tanks (Fig. 2) [Figure not reproduced] or directly on his combat formations. A salvo lays 720 mines.

The M56 helicopter mining system is intended for laying the M56 explosion-proof tank-disabling mines. It was taken into the inventory in 1973 and belongs to first generation equipment. Minelaying is done from heights on the order of 30 m and a mine strip 20 m wide is laid with one pass of a helicopter. The mines (a total of 160) are in cassettes and are fired in pairs from rails using a propelling powder cartridge. Then they separate and their fins open. After falling to the ground the mines arm automatically after a certain delay period (1-2 seconds) and function when tanks or vehicles drive over them. Three versions of the M56 mines usually are contained in a single set: with a fuse which functions from the first effect;

1. For more details see ZARUBEZHNOYE VOYENNOYE OBOZRENIYE, No 2, 1979, pp 51-52.--ed.

with a fuse to counter mineclearing rollers, functioning from the second effect (it is armed when the mineclearing roller passes over the mine and functions when the tank on which the roller is mounted influences it); and with a nondisturbance device by which the mine detonates in an attempt to remove it from in place or change its position. It is recommended that two passes be made or two helicopters be used simultaneously to obtain a minefield of the required depth. The table compiled from American press data gives the required number of helicopter sorties (with the expenditure of one mine load) as related to a given mine density and minefield length.

QUANTITY OF HELICOPTER FLIGHTS REQUIRED FOR LAYING A MINEFIELD OF REQUIRED LENGTH AND DENSITY

Density of minefield/m^2	Length of minefield/meters										
	100	200	300	400	500	600	700	800	900	1000	2000
0,01	1	1	1	1	2	2	2	2	3	3	5
0,02	1	1	2	2	3	3	4	4	5	5	10
0,04	1	2	3	4	5	6	7	8	9	10	20
0,06	2	3	5	6	8	9	11	12	14	15	30

Primary attention in development of remote mining systems in the FRG is being given to the creation of antitank systems of various types using a limited number of kinds of mines. For example, according to reports of the West German military press, two antitank mines (AT-1 and AT-2) have been developed for the Bundeswehr intended for scattering using remote equipment. The former already has been accepted into the inventory and its production has been arranged, while the latter is in the final stage of testing. According to statements by West German specialists, the second type of mine, which possesses greater efficacy, should receive widest use. It is planned to use it in several minelaying systems.

The MSM (Minenstreumittel) mine system will be in the inventory of Bundeswehr engineer units at the beginning of the eighties. It is planned to have two versions of it: ground-based and helicopter. The former (Fig. 3) [Figure not reproduced] is being made on the basis of the American M548 tracked transporter and will include six cassettes consisting of packets of tubular rails. Each has 20 tubes containing 100 AT-2 antitank mines (five in each). The cassettes are detachable, mounted on joints and can change elevation. Mines are fired from the tubes by means of explosive cartridges. The rate and range of fire are regulated depending on the requisite minelaying density and minefield length. In the helicopter version of the MSM minelaying system it is planned to mount two cassettes with mines, just as in the ground version, along the sides of an authorized Army Aviation helicopter.

The rocket minelaying system is represented in the Bundeswehr by the 36-tube 110-mm LARS [Light Artillery Rocket System] volley-fire rocket system, which has in its unit of fire a NUR with cassette warheads equipped with the AT-1 antitank mines. The maximum range of fire is around 15 km and the salvo length is 18 seconds. If necessary it is possible to fire half a volley. In the future it is planned to include projectiles with AT-2 antitank mines in the unit of fire of this RSZO [salvo-fire rocket system]. Some of the NUR's also will be loaded with these mines for the RS80 salvo-fire rocket system being developed in the FRG.

Reports have appeared in the foreign military press of late about a projected unification of efforts within NATO to create a common standardized salvo-fire rocket system. It is planned to make the American GSRS [General Rocket Support System] system its basis. It was reported in particular that the FRG would assume responsibility for the task of developing a NUR with a cassette-type payload loaded with the AT-2 antitank mines.

Military specialists in Great Britain are also working to create remote mining systems. The first model of such equipment (the "Ranger" antipersonnel mine system) has been accepted into the inventory and is being placed in series production. This system is intended for high-speed laying of antipersonnel blast mines chiefly for the purpose of strengthening antitank obstacles. Its primary components are the launcher (PU) and 18 cassettes with mines. A light frame fastened to a removable rotating platform serves as the launcher. The platform can be mounted on the top of an APC or on the bed of a standard truck. The cassette is a packet of four tubes containing 18 antipersonnel mines each. The cassettes are loaded with mines at the plant and those which have been used are quickly replaced with others ready to fire. There is a total of 1,296 mines in one load. They are fired to a range up to 100 m using explosive cartridges.

In the opinion of British specialists, it is most rational to use the new system together with the towed minelayer which lays distributed antitank mines. The PU of the "Ranger" system (Fig. 4) [Figure not reproduced] is accommodated on the roof of the F.V.432 "Trojan" tracked APC, which tows the minelayer. In this instance it is possible to lay mines of both types simultaneously. British military specialists have given a positive appraisal of the new minelaying equipment and consider it advisable to begin development of a new, small antitank mine which could be laid using the very same "Ranger" system. In addition, an opportunity is envisaged for accommodating this system on other mobile equipment, particularly on the recently created multipurpose "Centaur" wheeled-tracked vehicle.[2]

In recent years Italy has developed and begun production of a number of antitank and antipersonnel mines intended for laying by remote mining systems. The DAT helicopter mine system already is in the inventory of the Italian ground forces. Work is continuing on the creation of ground-rocket and artillery systems.

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2. See ZARUBEZHNOYE VOYENNOYE OBOZRENIYE, No 8, 1979, color insert.--ed.

The DAT helicopter minelaying system (Fig. 5) [Figure not reproduced] has a packet consisting of several standardized cassettes with antitank or antipersonnel mines (or a combination of them) and is suspended on the external suspension of a helicopter. One or more cassettes open at the pilot's command and the mines fall to the ground. Depending on the type of helicopter, it is possible to use various sets of cassette packets and the quantity of mines in one load changes respectively. For example, the AB205 helicopter is capable of carrying one packet with mines in the following combinations: 128 MATS antitank mines; 1,280 MAUS-1 antipersonnel mines; 64 MATS and 640 MAUS-1, or 96 and 320 respectively. The CH-47 helicopter can carry three such packets.

At the present time Italy is conducting advanced development of the SY/AT helicopter minelaying system similar to DAT, but differing only in the type of mines used. The SB-81 antitank mines and SB33 antipersonnel mines are used in it.

PHOTO CAPTIONS

1. p. 33. Fig. 1. The XM128 minelayer of the GEMSS ground minelaying system, from the journal MARINE CORPS GAZETTE.

2. p. 33. Fig. 2. Laying minefields with the American SLU-MINE rocket system, from the journal MILITARY ENGINEER.

3. p. 34. Fig. 3. The MSM West German ground minelaying system, from the journal WEHRTECHNIK.

4. p. 34. Fig. 4. The British "Ranger" remote minelaying system on the FV432 "Trojan" APC (with towed minelayer), from the journal INTERNATIONAL DEFENSE REVIEW.

5. p. 35. Fig. 5. The Italian DAT helicopter minelaying system, from the journal INTERNATIONAL DEFENSE REVIEW.

6904
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NATO: SOVIET REVIEW OF AIRCRAFT SERVICE LIFE

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 41-45.

[Article by Engr-Col (Res) L. Leonov: "Survivability of Warplanes and Ways to Increase It." Passages enclosed in slantlines printed in boldface]

[Text] In continuing preparations for war against the USSR and other states of the socialist community, aggressive circles of countries of the North Atlantic Alliance are attempting to increase the combat capabilities of their air forces, which are determined by the capability of aircraft and their crews to perform the missions assigned them under conditions of opposition by active air defense weapons.

In connection with this, as the foreign press notes, the efforts of military leaders of the United States and its NATO allies are aimed at accomplishing measures to reduce aircraft losses during combat operations, including to increase the survivability of warplanes. For example, a special joint technical group has been operating in the United States since 1971 with the primary function of coordinating work being performed in the armed forces and other interested departments and establishments to increase the survivability of aviation equipment.

The views of western experts and certain practical measures to resolve this problem which are being conducted in capitalist states are examined below.

/Aircraft survivability criteria/. In evaluating the survivability of aircraft in past wars and conflicts, foreign military specialists proceed from the following criteria: number of aircraft lost per 1,000 aircraft sorties or level of losses (the percentage of aircraft shot down per 1,000 or the total number of aircraft sorties for a certain period of combat operations is calculated); average number of weapons (projectiles, missiles) expended by the enemy to destroy one aircraft; duration of an aircraft's flight after receiving various damages.

Level of losses. In studying results of air combat operations from 1939 through 1973, foreign experts obtained the following results.

In Europe alone during World War II allied aviation lost around 40,000 aircraft, with the average level of losses being 2 percent, but it was considerably lower in major air operations. Foreign specialists explain this by the high effectiveness of measures performed to overcome the opposition of enemy air defense weapons. In particular, in major air operations against fascist Germany, the U.S. Air Force flew 4.4 million aircraft sorties (1.7 million for bombers and 2.7 million for fighters and ground attack aircraft). There were 18,000 aircraft shot down, i.e., four aircraft for every 1,000 sorties (a level of 0.4 percent). On the whole, however, their losses to air defense weapons in the war equalled nine aircraft per 1,000 sorties (0.9 percent).

In the Korean War (1950-1951) the average losses of American aviation were 4.4 aircraft per 1,000 sorties (0.44 percent).

During the aggressive war unleashed by the United States against the Vietnamese people, the American Air Force lost an average of three aircraft for every 1,000 sorties (0.3 percent). But this level reached 3 percent or more during raids against objectives located on the territory of North Vietnam, which forced the Air Force command to assign approximately 25 percent of the aircraft to perform REB [radioelectronic warfare--EW] and to suppress air defense weapons and only around 50 percent were used for immediate performance of the primary combat missions.

There were eight aircraft shot down (0.8 percent) for every 1,000 sorties by Israeli aircraft in the Near East (1973), while the level of losses of the A-4 "Skyhawk" ground attack aircraft reached 1-1.5 percent.

In analyzing the experience of past wars and taking account of the contemporary status of aviation and air defense weapons as well as the possible nature of combat operations, American military experts concluded that the use of aviation becomes unpractical if 20 or more aircraft (2 percent) are lost for every 1,000 sorties.

In the opinion of foreign specialists, the number of weapons expended per aircraft characterizes the survivability of its airframe, flying qualities, and the effectiveness of tactics used by the crew in penetrating enemy air defense, as well as the effectiveness of weapons which they employ.

As reported in the journal INTERNATIONAL DEFENSE REVIEW, at the beginning of World War I around 11,600 AAA rounds were expended to shoot down one aircraft, with approximately 5,000 used toward the end of the war as a result of an improvement in air defense weapons and the tactics of air defense forces, while an average of 6,800 were used to shoot down one aircraft in World War II.

Under present-day conditions, according to foreign military specialists' estimates, an average of 8,500 rounds (of 35-mm, 40-mm and 57-mm cannon) will be needed to shoot down an aircraft flying at a speed of 300 m/sec.

On the basis of data processed by American experts on the use of ZUR [surface-to-air guided missiles--SAM's] during combat operations in Vietnam, it was established that an average of 3-6 missiles are required to destroy one low-flying aircraft. The expenditure of ammunition for each aircraft shot down in aerial combat in the Korean War was 1,000 rounds from 20-mm cannon, and in Vietnam it was 500 rounds or 11 AIM-9 "Sidewinder" air-to-air missiles.

The length of time an aircraft flies after receiving damage basically characterizes the survivability of the airframe. The United States and certain other capitalist countries subdivide aircraft damage into five categories (given in Table 1).

Table 1 - Aircraft Damage Categories

Categories	Aircraft Flight Time After Sustaining Damage
1st (serious)	Up to 2 seconds
2d (serious)	Up to 15 seconds
3d (medium)	Up to 5 minutes
4th (medium)	Up to 30 minutes
5th (light)	Aircraft returns to airfield, where it is repaired

After generalizing the experience of past wars, foreign experts concluded that serious damages occur more rarely than medium and light damages. In particular, they note that damages of the 2d, 3d and 4th categories were 3 times, 8 times and 15 times more frequent respectively than that of the 1st category, while up to 24 percent of all American aircraft which returned from a combat mission had damage of the 5th category during World War II. These conclusions then served as the basis for projects to increase the survivability of airframes and for training crews to fly damaged aircraft.

/Factors affecting aircraft survivability./ According to views of foreign specialists, the primary factors are considered to be: probability of the aircraft's detection by air defense facilities; vulnerability of the airframe, aircraft systems and crew members; effectiveness of measures to help penetrate the enemy air defense system.

Probability of aircraft detection. The enemy can detect air targets visually and with the help of IK [infrared--IR] and radars.

The first depends on weather conditions. For example, according to calculations by NATO specialists, the range of visibility and recognition of a contemporary warplane under conditions of Central Europe does not exceed 3.5-5 km on the average, while a fighter flying at low altitude can be recognized only from a distance of 2.7 km, which considerably limits the capabilities of air defense facilities and thus increases the aircraft's survivability. The size and coloration of air targets has a great influence on the possibility of their being detected visually. The smaller the size and the more successful the coloration, the more difficult it is to detect and shoot down such a target.

IR equipment also is used to detect an aircraft both day and night. The range of detection with such equipment under Central European conditions is greater than that by visual means, and on the average is equal to 5-10 km. The primary sources of thermal radiation of an aircraft when flying at subsonic speed are the hot parts of the engines, streams of exhaust gases, electronic gear, and also the leading edges of the wing and air intakes.

The range of radar detection of an aircraft depends not only on its tactical and technical characteristics, but also on the area of the aircraft's effective reflecting surface, which in turn is determined by its size as well as by the shape and properties of structural materials and covering.

Vulnerability of airframe, aircraft systems, and crew members. Research performed abroad has shown that the vulnerability of any aircraft and its crew is determined by the effectiveness of weapons being employed by the enemy and features of the airframe and its protection.

The foreign press quoted selected data on effectiveness of damage to aircraft by AAA rounds and fragments of ZUR (it is considered that a direct hit by a ZUR leads to destruction of the target).

In particular, the journal INTERNATIONAL DEFENSE REVIEW published a chart for determining the number of hits by various caliber rounds needed to shoot down a specific type of aircraft (Fig. 1, on left) [illustrations 1 and 2 and Table 2 are not included in this translation]. It also includes a table which shows the amount of explosives in a round needed to destroy an aircraft with a direct hit (Table 2). Fig. 1 (on right) shows a chart for determining the effective distances for detonation of missile warheads of varying yield which ensure damage to an aircraft. It is calculated for altitude (under conditions of standard atmosphere). It is noted that the effective distance reduces by 50 percent at an altitude of 10,000 m and by 85 percent at an altitude of 20,000 m.

But the journal stipulates that it is giving only estimated data, which may differ sharply from reality depending on the vulnerability of airframe elements of a specific aircraft.

Foreign military specialists include the pilot, the aircraft's fuel system, flight control system and engines among the most vulnerable elements, and durable elements of the fuselage and wings among the most long-lived. In their opinion, damage to weapons and electronics may lead to nonaccomplishment of the mission, but the aircraft and crew will return to base.

Aircraft survivability is linked closely with its so-called restorability, i.e., the opportunity for repairing damages within a certain time interval. In the opinion of foreign specialists, repairs will contribute to an increase in aircraft combat readiness only when they can be performed under field conditions. The foreign press gives the A-10A ground attack aircraft as an example of a modern warplane with a low vulnerability and good restorability indicators. Accommodation of elements of its airframe from the standpoint of time periods for their restoration is shown in Fig. 2.

Measures to ensure the penetration of enemy air defense system. According to views of foreign experts, the primary measures include use of the most advantageous altitudes and flight speeds; proper selection of routes and directions of approach to target; antiradar, antimissile and anti-AAA maneuvering; using active and passive jamming of radars, infrared sensors and other equipment for the detection of air targets and control of air defense forces and weapons; and the destruction or suppression of the most important objects in the enemy air defense system.

/Increasing aircraft survivability./ Military specialists of the United States and other NATO countries believe that it is possible to increase aircraft survivability through a reduction in the probability of their detection, a reduction in the vulnerability of the aircraft itself and of its crew, an improvement in onboard EW gear and weapons, and development of operating tactics. According to their views, it is possible to reduce range and probability of detection by flying at low altitude, by limiting the use of afterburner power settings, by shielding the hottest parts of engines, and by using camouflage paints and radar-absorbing materials.

An increase in survivability of the aircraft and crew is provided by armor-protection of cockpits; accommodation of crew members one after the other (in tandem), separated by a transparent armored partition; increasing the number of engines in the power plant; redundancy of aircraft systems; providing self-sealing fuel tanks; equipping the aircraft with special firefighting gear; and proper selection of a location for ammunition.

These measures are especially effective, in the opinion of foreign specialists, when they are conducted in an integrated manner and are implemented in programs for creation of new aircraft. For example, the pilot's cockpit in the A-10 ground attack aircraft is protected by titanium armor capable of withstanding hits by 23-mm rounds, the aircraft's hydraulic control system is duplicated by a mechanical cable system, each of the two engines provides for flying the aircraft in case one of them is disabled, the fuel tanks are self-sealing and so on. The "Tornado" aircraft has a relatively small size, two engines, two crew cockpits separated from each other, two independent hydraulic systems, triple redundancy in the control system, self-sealing fuel tanks and diversified weapons.

To increase their survivability, aircraft are outfitted with guided missiles (bombs) which can be launched (dropped) before entering the enemy's air defense coverage; with special gear which warns of radar illumination of the aircraft; and with systems for creating active and passive jamming of detection, guidance and control radars and of missile homing heads. In order to destroy enemy radar used to control ZUR fire, aircraft are equipped with "Shrike," "Standard" ARM and other missiles which home on a source of electromagnetic radiation.

Aircraft operating tactics also are being improved. Primary attention is beign given abroad to mastering flights at low altitudes, creation of jamming of detection and guidance radar and IR equipment, the use of anti-AAA and antimissile maneuvers, and assignment of combat support forces for reconnoitering air defense weapons, for their suppression, destruction and confusion through deception measures, and for screening attack groups of fighters.

6904
CSO: 1801

U.S. ANTI-AIR-DEFENSE AIRCRAFT: SOVIET COMMENT

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 46-48

[Article by Col I. Chistyakov: "U.S. Air Force 'Wild Weasel' Program"]

[Text] Viewing tactical aviation as one of the most important means for achieving its aggressive goals in a future war, the Pentagon is constantly increasing its tactical capabilities, especially for use in a TVD [theater of military operations] under conditions of heavy opposition on the part of enemy air defense.

To this end, the U.S. Air Force leaders envisage the conduct of specific activities, primary among them, as attested by the foreign press, being the suppression and destruction of active air defense facilities. Having studied the experience of combat operations in Southeast Asia and the Near East, American military specialists continue to regard control entities, particularly radar, to be the most vulnerable spot in modern air defense systems. It is planned to concentrate primary efforts of forces and facilities supporting combat operations by tactical aviation at putting them out of action.

A program conducted by the U.S. Air Force Tactical Air Command under the codename "Wild Weasel" is an example of this approach to resolving this problem. According to foreign press reports, the refitting of series-produced tactical aircraft into aircraft specially designed for suppressing and destroying air defense systems is being done in conformity with this program (in the foreign press these aircraft are designated according to the name of the program, such as the F-4G "Wild Weasel"). According to the views of western military specialists, depending on the situation, such aircraft may operate independently from an air alert status or as part of strike groups performing direct air support of ground forces. In each of these instances, they accomplish the mission of combating enemy ground control facilities for fighters, ZRK [SAM systems] and ZA [AAA] through the detection, identification and position-fixing of emitting detection, target designation and guidance radars, as well as through their destruction using onboard ordnance. According to calculations by foreign military specialists. this should reduce the effectiveness of the air defense system.

According to foreign press reports, the practical implementation of the program began in 1966 with the conduct of combat operations in Southeast Asia. F-105F fighter-bombers equipped with REB [electronic warfare--EW] gear controlled by an operator from the second cockpit, were used as "Wild Weasel" aircraft. In addition, RB-66 reconnaissance aircraft made on the basis of the B-66 bomber also were used.

Somewhat later, during barbaric bombings of the territory of the DRV, the American aggressors employed specially equipped F-105G and EB-66 aircraft with EW gear and weapons aboard. In particular, every F-105G aircraft had a detection receiver aboard and carried a suspended pod with electronic countermeasures [ECM] gear and four "Shrike" antiradar UR [guided missiles] or two "Standard" ARM missiles. According to foreign press information, a total of around 40 F-105G's were equipped under this program.

Beginning in 1970, the U.S. Air Force used a portion of F-4C fighters (two squadrons, 34 aircraft) equipped with special gear and weapons for suppressing and destroying ground air defense facilities in combat operations in Southeast Asia. Installed in them were reconnaissance receivers, jammers, chaff dispensers, and antiradar UR's. The foreign press noted that the "Wild Weasel" aircraft demonstrated a rather high degree of effectiveness and successfully accomplished the missions assigned them.

In the opinion of American military specialists, the role of "Wild Weasel" aircraft in supporting tactical air operations will increase immeasurably under conditions of the European Theater of War, saturated with electronic emitters. This spurred the U.S. military leadership to continue work to improve onboard equipment and weapons for the "Wild Weasel" aircraft. The F-4E fighter, which was designated the F-4G after modernization, was chosen as such an aircraft. Modernization consists chiefly of removing the "Vulcan" 20-mm gun and replacing it with appropriate electronic gear--the APR-38 system. It includes a detection receiver, signal analyzer, electronic computer, situation display, antenna system and auxiliary equipment.

The receiver is designed for use in a sophisticated electronic environment and so its operation and the processing of data received has been automated using a digital computer. The antenna system provides a panoramic view. The direction-finding of radiation sources is done with high accuracy, which makes it possible to employ not only antiradar guided missiles against detected targets, but also other ordnance (the "Maverick" air-to-surface UR, guided bombs and bomb clusters). Data on signals being sought and intercepted are displayed on scopes located in the cockpits of the pilot and operator of the electronic gear.

In addition to the APR-38 system, the F-4G aircraft is equipped with built-in ALQ-131 EW gear and suspended pods with ALQ-119 jammers, the "Sparrow" or "Sidewinder" air-to-air UR's (for aerial combat), as well as various antiradar UR's ("Shrike," "Standard" ARM or the HARM, which is under development) and other ordnance. In this regard the Air Force command is presenting higher demands on pilots: They must have a sufficiently large number of flying hours aboard F-105 or F-4 aircraft and be capable of conducting aerial combat and delivering strikes against small ground targets using both guided and unguided weapons.

The plans of the American command envisage having 116 F-4G aircraft in the Air Force inventory (96 in combat units and the remainder for pilot training and for the reserve). Some of them will be deployed in Western Europe (according to the foreign press, the first aircraft already have arrived at the disposal of the U.S. Air Force command in Europe).

At the present time the United States is conducting investigations to select a prospective "Wild Weasel" aircraft to replace the F-4G. Thus, according to foreign press reports, the General Dynamics firm is studying the possibility of creating a variation, which has received the codename F-16 "Wild Weasel" and intended for identification and destruction of enemy ground air defense facilities, on the basis of the two-place F-16B fighter (see color insert). As the firm's specialists note, some countries which are members of the NATO bloc and which are purchasing the F-16 fighter have shown interest in this modification. In addition, in choosing the F-16B as a "Wild Weasel" aircraft, American experts referred to its advantages: relatively low cost with, at the same time, the capability of carrying a significant payload on external attachment points (over 6,000 kg) and a fuel reserve sufficient for performing assigned missions (2,620 kg in internal tanks and around 2,200 kg in auxiliary tanks).

In addition to special onboard electronics, particularly the AN/ALR-46 electronic intelligence set, the F-16 "Wild Weasel" aircraft will be able to carry diverse weapons in various versions. The pages of foreign military journals provide some variations of its payload: two pods with antennas at the wingtips (instead of the "Sidewinder" UR), a pod with EW gear under the fuselage, two auxiliary fuel tanks, and the "Shrike" and "Standard" ARM antiradar UR's on wing attachment points (see illustration) [Illustration not reproduced] or two HARM UR's and three "Maverick" UR's.

Reports have appeared in the foreign press that the American firm of McDonnell-Douglas also is examining the possibility of creating a "Wild Weasel" aircraft on the basis of the F-15 fighter. The firm's specialists cite as the new aircraft's advantages its high thrust-to-weight ratio and considerable fuel reserve, which can almost be doubled by installing quick-detachable fuel tanks which protrude little beyond the fuselage lines, i.e., the "Fast Pack" system.

The nature of work being done in the United States to improve "Wild Weasel" aircraft in the inventory and to create new such aircraft attests to the unremitting attention of American strategists to a search for tactical air support forces and means for penetrating enemy air defenses, by which they unambiguously take to mean the Soviet Union and other countries of the socialist community.

6904
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NATO: SOVIET COMMENT ON NAVAL TRAINING EXERCISE

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 59-61

[Article by Capt 3d Rank V. Kaminskiy: "Navies of NATO Countries in Exercise 'Dawn Patrol-79'"]

[Text] Ideas of detente are making themselves known more and more perceptibly in the international arena, but certain imperialist circles are setting every means in motion to retard this objective process. These forces are pursuing just such a goal in conducting exercises and maneuvers of varying scale. As pointed out in the foreign press, they are used to practice various versions for unleashing armed conflicts primarily against countries of the socialist community, and to train staffs, troops and naval forces to conduct combat operations under near-real wartime conditions. The annual exercises of joint NATO armed forces in the Southern European TVD [Theater of Military Operations] under the codename "Dawn Patrol" are devoted in particular to the accomplishment of these missions.

An exercise of this sort was conducted in 1979 from 12 through 24 May in the western, central and eastern Mediterranean, as well as on the territories of Italy and Turkey. Its primary objective was to work out problems of converting NATO armed forces in the Southern European TVD from a peacetime to a wartime footing, to reinforce them by moving air force subunits and naval ships of the United States and Great Britain from the Atlantic, and to conduct operations of the initial period of a limited war without the use of nuclear weapons.

The command elements and staffs of joint and national armed forces, units and subunits of the ground forces, the 5th and 6th OTAK [joint tactical air commands], attack and joint naval forces of NATO in the Southern European TVD, Marine subunits, and forces and facilities of the southern zone of NATO's joint air defense system were used for the exercise. As noted in the foreign press, a total of around 90 warships and auxiliary vessels of navies of the United States, Great Britain, France, the Netherlands, Italy, Turkey and Greece took part in it, including American and French multipurpose carriers ("Dwight D. Eisenhower," "America" and "Clemenceau"); over

400 strategic, tactical, carrier-based, coastal patrol and reconnaissance aircraft (of which up to 250 were carrier-based aircraft and helicopters); and 3,500 American, British, Italian, Greek, Turkish and French marines.

The following problems were worked in the exercise: formation and deployment of task forces and groups for various specific purposes in areas of combat missions; combating "enemy" naval groupings in the interests of winning sea supremacy; conducting amphibious landing operations; giving direct air and ship (gun) support to ground forces operating on maritime axes; and organizing the defense of sea lines of communication.

Overall leadership was exercised by the commander in chief of joint NATO armed forces in the Southern European TVD, while immediate control of operations of the forces at sea was exercised by commanders in chief of the attack and joint naval forces through the commanders of task forces and groups.

Forces in the exercise were broken down into "Blue" (NATO Joint Armed Forces) and "Orange" ("enemy"). Participating on the "Blue" side were surface ships including the multipurpose carriers "Dwight D. Eisenhower," "America" and "Clemenceau" as part of NATO's naval attack forces in the Southern European TVD, Marine subunits, strategic, carrier-based, tactical and coastal patrol aircraft, and personnel and facilities of the southern zone of NATO's joint air defense system; and on the "Orange" side were nuclear-powered and diesel-powered submarines, a few surface ships as part of ship attack groups, guided missile and torpedo boats, and separate units and subunits of the ground forces and tactical aviation.

Taking place in the first phase of the exercise was the deployment of forces in tactical mission areas (western and central Mediterranean); formation of task forces and groups; hunting, pursuit and "destruction" of "enemy" submarines in parts of the Adriatic, Tyrrhenian and Ionian seas and on antisubmarine barriers; a practice amphibious landing in Teulada Bay (island of Sardinia).

The amphibious landing of a total of up to 2,500 Marines was conducted from one Italian and seven American amphibious warfare ships by means of ships' landing craft. It was supported by ship hunter-killer groups deployed in the Tyrrhenian Sea, Gulf of Tunis and southwest of the island of Sardinia. Coastal patrol aircraft and ship-based helicopters performed a hunt for and "destruction" of "enemy" submarines. Deck-based aircraft from the carrier "America" and "Clemenceau," located up to 100 nm from the island of Sardinia, provided air support to the landing force and its operations ashore.

The following missions were accomplished in the second phase: winning supremacy in the Ionian Sea, Sea of Candia and Aegean Sea; supporting the passage of a joint amphibious landing force from Teulada Bay to the Turkish coast; escorting a convoy with reinforcing troops and combat equipment from the western Mediterranean (Strait of Gibraltar) to Italy; conducting an amphibious landing operation on the Turkish coast; and providing direct air support to a grouping of ground forces in Northern Italy and to the amphibious landing force during its landing and operations ashore.

The winning of sea supremacy was assured through the joint efforts of ship attack and hunter-killer groups and carrier-based and tactical aircraft. Carrier-based aircraft operated in groups from several directions simultaneously in delivering strikes against "enemy" surface ships.

The passage of the joint amphibious landing force from Sardinia to the Turkish coast took place in the presence of active "enemy" submarine and fighter-bomber aviation operations and under conditions of mine danger in straits and narrows. The force was screened by carrier-based and tactical aviation, with deck-based fighters operating as part of combat air patrols on threatened axes at a distance up to 30 nm from the carriers.

The amphibious force was landed in Doganbey Bay (Turkey) with the help of ships' landing craft and helicopters. Its landing was preceded by air and artillery support by carrier-based and fighter-bomber aircraft as well as ships of the fire support detachment. Ship hunter-killer groups isolated the landing area and provided antisubmarine support to the anchoring of landing ships and transports. Beach defense was conducted jointly by units and subunits of the ground forces and fighter-bomber aircraft of Turkey.

A convoy escort was organized from the vicinity of Gibraltar to the Italian coast under conditions of mine danger and opposition on the part of "enemy" submarines and aircraft to practice problems of defending sea lines of communication in the western Mediterranean.

Other missions also were accomplished in the exercise: patrol of all-arms forces, interaction of naval forces with tactical aviation for delivering strikes against "enemy" ship groupings coordinated by place and time, performance of reconnaissance, organization of all kinds of defense of ship forces during the sea passage and at anchorages, mine warfare support to force operations and to ships behind sweep gear and logistical support of ships at sea. Special attention was given to the use of REB [electronic warfare] facilities to disrupt the control and communications system, to confuse the "enemy" and to suppress his detection and fire control radars.

Exercise "Dawn Patrol-79" once again shows that the champions of such ventures clearly attempted to poison the international atmosphere and provide a new impetus to the fanning of tensions in this uneasy part of the world.

6904
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NATO: SOVIET COMMENT ON USE OF BLACK SEA STRAITS

Moscow ZARUBEZHNOYE VOYENNOYE OBOZRENIYE in Russian No 9, Sep 79 signed to press 4 Sep 79 pp 61-67

[Article by Capt 1st Rank A. Korablev: "The Black Sea Straits (Physical Geographic Conditions, Regime of Navigation, Elements of the Infrastructure)." Passages enclosed in slantlines printed in boldface.]

[Excerpts] The Black Sea Straits is the overall name for the Bosporus, the Dardanelles and the Sea of Marmara situated between them (Fig. 1) [Figure not reproduced], which form the only route of communications between the Black and Mediterranean seas.

The /Bosporus/ (Fig. 2) [Figure not reproduced], which separates Europe and Asia, represents a winding strait with high, precipitous banks.

The /Dardanelles/ is the strait connecting the Sea of Marmara with the Aegean Sea. It is over 60 km long, 4-7 km wide and around 1.3 km wide in the narrowest place (near Canakkale). The banks of the strait are low and monotonous, formed from sandstone and limestone and covered by sparse vegetation. There are no bays or inlets. The water turnover through the Dardanelles is determined by the difference in water density of adjoining seas. A surface current from northeast to southwest takes freshened water with a lesser density (1.018) from the Sea of Marmara at a velocity of 2-6 km/hr. A deep current with the reverse direction carries saline (38 parts per thousand) and dense (1.029) waters from the Aegean Sea.

The /regime of the Black Sea Straits/ presently in existence is determined by a convention concluded in 1936 in Montreaux (Switzerland). It provides for free passage through the straits by any number of merchant vessels of all states both in peace and in war.

The transit of warships of non-Black Sea countries in wartime is prohibited, and in peacetime it is limited by the class of ships, their period of stay in waters of the Black Sea, and by tonnage (only light surface ships can be taken through for a period up to 21 days, and their overall tonnage must not exceed 45,000 tons).

The transit of warships of Black Sea states in peacetime is declared free if the Turkish government is informed of this at least 8 days ahead of time and on condition of the fulfillment of certain requirements. For example, it is authorized to pilot surface ships of any tonnage equivalent to a class of battleships (they must proceed singly escorted by no more than two destroyers), as well as submarines (by day, singly and in a surface condition).

According to the Convention, in wartime, if Turkey is not a participant, the transit of warships of the belligerents is prohibited; and in case Turkey enters the war or is threatened by direct military danger, the Turkish government has the right to authorize or prohibit the transit of any warships through the straits. It is generally known, however, that during World War II the country's leaders declared their neutrality after Germany's attack on the Soviet Union and granted the fascist invaders an opportunity to make use of the Black Sea Straits for their own purposes, in violation of the aforementioned provisions.

/Elements of the infrastructure./ In the estimate of the foreign press, the strait zone has a ramified network of naval bases, ports, convenient bays for basing and anchorages for warships and vessels of practically any displacement. [Brief description of the most important infrastructure elements follows. Not translated.]

/The Black Sea Straits and the NATO bloc./ The NATO bosses, and American strategists above all, attempt to explain the heightened interest in the strait zone by the very same imaginary "Soviet military threat," particularly "to Turkey and her straits," which long ago set people's teeth on edge. As the foreign press has written, "defense of Western Europe is inevitably linked with security of the Mediterranean area. But Russia's egress to this sea lies through the Turkish straits." Therefore "inclusion of the Mediterranean in the zone of protection of the Atlantic Alliance" and Turkey's entry into NATO increase "United States interests in their defense" and give the straits "primary importance in Washington's geostrategic approach." Turkey's proximity to the Soviet Union and the presence of the Black Sea Straits zone within the country's limits forces the United States to undertake any measures to keep Turkey within NATO, in the opinion of western observers.

Judging from foreign press reports, Turkey's territory, air space and coastal waters have been included in the "zone of responsibility" of the Supreme Command of NATO Joint Armed Forces in the Southern European TVD [Theater of Military Operations]. Defense of the strait zone within the framework of the alliance is made the direct responsibility of the command of NATO's joint ground forces in the southeastern part of the TVD (headquarters in Izmir), the command of the 6th OTAK [Joint Tactical Air Command] (same location) and command of joint naval forces in the northeastern part of the Mediterranean (headquarters at Ankara).

In the views of foreign military specialists, in case of war the Turkish Armed Forces "will not be able to hold the Thracian Front and the strait zone by themselves against strong enemy attacks from the land, air and sea." Therefore "to give rapid assistance in defending the straits in a local conflict," so-called "mobile forces" have been set up within the framework of the bloc. But the Sixth Fleet, which the American press openly terms the "guardian of the straits," is the primary "defender of United States interests in this region." The role of "a screen of the strait zone" is given to the Turkish Armed Forces in NATO plans: responsibility for covering it in Eastern Thrace is given to forces of the 1st Field Army (headquarters at Istanbul), to forces and weapons of the 1st Tactical Air Army (Eskisehir) from the air, and to the command of the Northern Naval Zone (Istanbul) from the sea.

According to foreign press reports, the 1st PA [Field Army] includes four army corps, which include ten divisions and four separate brigades. Units of the 1st PA are stationed in eastern Thrace and on the Kodzhaeli Peninsula.

The 1st TVA [Tactical Air Army] is associated with four air bases: Eskisehir (two F-100D and F-100C fighter-bomber squadrons and one squadron of F-4E aircraft), Murted (two F-104S and F-104G fighter-bomber squadrons and one squadron of F-102A fighters), Bandyrma (two F-5A fighter squadrons) and Balikesir (one squadron each of F-100D and F-104G fighter-bombers and one squadron of RF-5A reconnaissance aircraft). Along with fighter aviation, air defense facilities of the strait zone also include two groups (four squadrons each) with 72 "Nike-Ajax" and "Nike-Hurcules" ZUR [SAM] launchers located in the vicinity of the Bosporus.

Four naval regions are subordinate to the command of the Northern Naval Zone: Black Sea, Bosporus, Dardanelles and Sea of Marmara. They are considered operational and have no ship forces under ordinary conditions. Depending on the nature of operations (exercises) being planned by the command of this zone, the required number of ships is assigned from the fighting forces of the Navy.* Naval region commanders bear responsibility for performing the following missions: blockading the straits, supporting all kinds of coastal defense, supporting the maritime flank of ground forces, and moving personnel and combat equipment through the strait zone.

During World War II, in order to screen immediate approaches to the straits, the Turkish command created the Bosporus and Dardanelles fortified areas (now the commands of the corresponding naval regions) with the mission of preventing the transit of surface ships and submarines through the straits from the Black and Aegean seas.

Batteries of 100-240 mm coastal artillery and sea-search radars were set up in the vicinity of Rumelifeneri (on the European bank of the Bosporus) and Anadolufeneri (on the Asiatic side) for combating large surface ships, and batteries for defense against motor torpedo boats were set up at the water's edge. The latter also are situated in other areas along the straits. There

*For the order of battle of the Turkish Navy see ZARUBEZHNOYE VOYENNOYE OBOZRENIYE, No 6, 1979, pp 59-64.--ed.

is a basing point for minesweepers, minelayers, netlayers, small combatants and auxiliary vessels of the Turkish Navy and stores of mines and boom and net defenses in the vicinity of Beikoz. There are also stores of mines and net and boom gear in the Dardanelles (Canakkale). Special stations are situated at the entrances to the straits for monitoring and observing the movement of foreign ships.

"Protection" of the strait zone is constantly being practiced in various exercises both of the Turkish Armed Forces and of Joint Armed Forces of the NATO bloc. NATO exercises such as "Deep Furrow," "South Express," "Marmara Express" and others conducted in recent years have had the purpose of working out problems of reinforcing the grouping of bloc member country ground forces in the zone of the Black Sea Straits. During the exercises there was a practice landing of airborne and amphibious forces on Turkish territory and its coast, and a move by subunits of mobile ground forces and air forces from the Central European TVD to regions of Eastern Thrace. These forces took part in "combat operations" together with national forces of Turkey. The foreign press even reported that "tactical nuclear weapons may be used in defending the strait zone in Thrace." According to the concepts of NATO strategists, this should provide "rather effective protection of the straits."

All this profuse talk about "protection" of the strait zone is intended for cloaking the true intentions of leading circles of the NATO bloc to use the Black Sea Straits for carrying out their aggressive plans in the Black Sea basin.

The American press has emphasized repeatedly that this region has decisive significance for all NATO strategy in the Southern European TVD. Therefore the NATO countries headed by the United States presently are using all means of pressure, including economic and military-political levers, to consolidate their military presence in Turkey--an important NATO strongpoint controlling routes from the Black Sea to the Mediterranean, and to activate this country's military role on the bloc's southern flank.

It is generally known that any state is viewed by American imperialists primarily from the viewpoint of an opportunity of using its territory for actions against the Soviet Union and other countries of the socialist community. And Turkey, to which the United States is applying "arm-twisting" tactics in order to include her more completely in the Pentagon's aggressive plans, is no exception. As the foreign press attests, such intentions cloak a threat to peace and security for nations of the Mediterranean area and in no way correspond to the spirit of the times.

6904
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FIRST STEPS TOWARD SOVIET SPACE ENGINES

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[Article by A. M. Isayev:[1] "First Steps Toward Soviet Space Engines: 1941-1947"]

[Text] In November 1941, a train approached a small railroad station in the Central Urals. This was one of the many trains stretching from west to east at that time, trains with people and equipment to forge weapons in the heartland to fight the enemy. The designers and workers who had disembarked at the small, old pipe-casting plant had to finish developing a new type of fighter as quickly as possible. This was the first Soviet propellerless aircraft. A liquid-propellant rocket engine would give it a tremendous rate of climb. Such a fighter would not have to fly on patrol while waiting for an enemy bomber; moreover, it would not have enough propellant for this. It would wait for the enemy on the ground. It would launch when the enemy was already overhead. There would be 2-3 minutes of almost vertical flight and a single, completely unexpected, unavoidable attack with its two aircraft cannons. With empty tanks, it would descend for refueling and for a new sortie-shot.

At the station, Chief Designer V. F. Bolkhovitinov's Experimental Design Bureau disembarked. The originator of the idea[2] of a rocket-propelled interceptor, A. Ya. Bereznyak, worked in this bureau. At the beginning of 1941, he had already suggested the development of a design for such a vehicle to Isayev, his friend. Together, they began to develop intercept charts and to center and configure various versions of the strange vehicle; they established contact with the engine specialists. The group headed by L. S. Dushkin[3]--the designer of liquid-propellant rocket engines--was located in small, round buildings behind a green fence on a quiet lane. They showed Isayev and Bereznyak their entire collection of steel vessels with their narrow throats and conical funnels: "This engine here has a thrust of 150 kg; this one is a little bigger, 300 kg; this engine is 500 kg and this one over here (we haven't finished it yet) has a thrust of 1,100 kg." They also showed them the thick-walled cement bays where the strange vessels were put into operation by injection kerosene and nitric acid into them. The 1,100 kg thrust was suitable. Dushkin's specialists were also developing a turbo-pump unit for this engine; it would take the unconventional propellant from the tanks and pump it to the engine under a pressure of 50 atmospheres.

While hiding it from their boss, Bereznyak and Isayev drew Dushkin's combustion chamber into the tail of their vehicles; they put in the tanks and the turbo-pump unit. Of course, such strange behavior by the two designers could not help but be noticed by Viktor Fedorvich Bolkhovitinov when the job assigned to them was obviously not progressing but both of them were working like mad at the same time. But, he decided to wait until his colleagues came to him and told him themselves. Then, he appreciated their idea and from that time on they worked in the open under the chief designer's supervision and management. The vehicle's outline was taking shape and its tactical capabilities were emerging.

Meanwhile, at Dushkin's, the chamber appeared to begin working but the development of the turbo-pump unit was lagging behind. Once, Isayev held a meeting on a version of the vehicle without this unit. He decided to try other alternatives: what would the vehicle be like if the propellant was forced out of the cylinders by compressed air instead of by the turbo-pump unit? What if the vehicle were scaled-down by half: make it a ton and a half vehicle instead of a three-ton one? A ton and a half vehicle would work. There would be less fuel, engine operating time would be reduced and the trajectory would be steeper but enemy pursuit and intercept would be guaranteed since the intercept zone remained rather large. During the night, the rough drawing was completed. Sunday morning arrived. Isayev turned on the radio.... It was 22 June 1941.

In three weeks, the preliminary design of an interceptor with a liquid-propellant rocket engine--which was designated the BI based on the initial letters of Bereznyak's and Isayev's last names--was completed. This design, signed by aircraft designers Bolkhovitinov, Bereznyak and Isayev and by the engine designer Dushkin, was sent to the chairman of the State Defense Committee. The authors were rather quickly summoned by the People's Commissar for the USSR Aviation Industry, A. I. Shakhurin, and told that the design was approved and they had a month to complete it. The entire group began working feverishly. The designers made rough drawings and went to the shops. The design work was still not finished when the wing was taken out of the jig. The monocoque fuselage was covered with a veneer sheet and the equipment was installed in it right on the spot. The gear struts had already been made, the canopy was attached and the cannons were installed. Caught up with the enthusiasm, the small, cohesive group of workers and engineers rolled their first vehicle out of the assembly shop 30 days later. It was sent to the Central Aero-hydrodynamic Institute's new, large wind tunnel for tests. The vehicle was so small that it completely fit in the tunnel. Another vehicle was made to be towed behind an aircraft. Then, the first engine was delivered to Bolkhovitinov's Experimental Design Bureau. It was installed in a steel truss made from the propellant cylinders; the pilot's seat and the throttle were in front of the cylinders. They began to check out the propulsion system.

Now, it is even frightening to recall what this propulsion system was like! The nitric acid cylinders were made from Cromansil. The thrust control throttle was also made from simple steel. A small, oxygen pressure reduction valve from a welding machine was installed to reduce the pressure of the compressed air delivered to the propellant cylinders. The entire assembly was made from 20-mm aluminum-magnesium alloy tubes. The throttle was jammed in, the Cromansil cylinders were badly corroded and the joints on the external cone were scored. Why there were no unfortunate incidents is a complete mystery. Dressed in oil-skin jackets, flight helmets and with their gasmasks at their side, Dushkin's mechanics worked mysteriously near the tail. Bolkhovitinov's first "liquid-propellant engine" mechanics--A. M. Smirnov and 16-year old Oleg Shtin--were beginning to get used to the nitric acid vapors, which rose in clouds over the bench when there were spills. Sometimes, test firings were made. Fire, smoke, stench and a frightening roar. Then, the mechanics leaned into the nozzle with a long scraper and swept out the pool of black liquid, which had accumulated in the chamber, on to the ground and they counted the holes in the nozzle throat. The spark plugs in the injection head were only sufficient for the first firing. Week after week passed and engine development was not progressing.

At that time, the fascist air raids on Moscow had begun. Biting their lips, the designers and mechanics stood around their smelly, firing unit and watched the Moscow skies being cut by the beams of search lights and anti-aircraft tracers. Squadrons of combat aircraft were already based at the plant airfield. The plant had received an urgent front line order to install new cannons on the MIG's. Preparations were underway to destroy the entire production unit if the critical time arrived. They received the order: load on to trains and leave for the East. Within a few hours, on 25 October, the plant equipment was removed and loaded along with the BI vehicles, the engine test bench, tanks, cylinders and tubes. The employees and their families got on board. The Bolkhovitinov group left for the Urals.

The intensely desperate work led to the situation where test pilot G. Ya. Bakhchivandzhi had already accomplished the first flight in the history of aviation in the first Soviet rocket-propelled fighter on 15 May 1942. Several other test flights were conducted later.

With the understanding that they could no longer rely on future joint work with the Jet Propulsion Scientific Research Institute to develop the engine, Bolkhovitinov suggested that Isayev transfer his interests in a fuel system to another person and work closely on the engine to support the Experimental Design Bureau's future work. The first days were especially difficult. He had no literature or teachers. But, Isayev was able to find out about a certain V. P. Glushko (now an academician), who was working in this field. Bolkhovitinov and Isayev immediately set out to see him. At the aircraft plant's design bureau, they found a man who knew engines. V. P. Glushko willingly showed them his bench areas and his production and design sections; he gave them a thermo-dynamic cooling design. Under his guidance, they received a thorough explanation which could not even be compared to their previous amateurish work. Isayev elatedly returned from Glushko's shop and began to operate more boldly, both on paper and on the job.

The first designs of individual units appeared. A new combustion system began to take shape--using a precombustion chamber and an aircraft spark plug which ignited the mixture of benzene and air. This precombustion chamber was attached to a birch tree which grew on the bank of the plant pond. It noisily spouted fire and was the first article for firing tests. Isayev was extremely interested in future firing benches at that time. At the Pervouralsk New Pipe Plant, Isayev pulled stainless steel pipes out of the dump buried under a pile of rubbish. They put everything into the job that could be found. Meanwhile, after mastering Glushko's design methods, the designers refined them further.

In May 1943, the Experimental Design Bureau returned to its old facility from the Urals; they began to set up an engine division. The following people worked in it: L. A. Pchelin, A. A. Tolstov, V. F. Berglezov, I. I. Raykov, G. G. Golovintsova, V. G. Yefremov, N. I. Korovin and others. Three walls of an unfinished hangar towered above the northern part of the plant's territory. They built a 300 square meter cinder block facility attached to the center wall; in the summer of 1943, the entire engine division moved here. The northern end accommodated a firing bench with two work areas. The central area contained the compressor, the instrument room, the storeroom and a hydraulic bench for nozzle flow tests. Then, there was the design bureau and, further on, a workshop with two lathes. Everybody was very satisfied with the facility: they were comfortable, self-contained and complete! In the winter, it was even warm there. Two stoves had been built; due to the lack of wood, they were heated with bricks soaked in kerosene. It was not clear why these stoves filled up the rooms with soot. Overall, from the modern point of view, the experimental facility was extremely primitive both in its engineering parameters and in its measuring systems and, it was simply intolerable in safety procedures, sanitary conditions and fire safety.

By the spring of 1944, the benches were basically all set up and the division felt that it was capable of serious, independent work. Bolkhovitinov decided to make their first assignment official through the government: "Develop a multiple-firing, aircraft liquid-propellant rocket engine for a thrust envelope from 400 to 1,100 kg, with smooth control, with a specific impulse of at least 200 seconds and a total burn time of 30 minutes; and present it in October of the same year." It was designed to replace the engine designed by the Jet Propulsion Scientific Research Institute on the BI aircraft in order to continue the vehicle's development which was interrupted by Bolkhovitinov's death in 1943. The primary employees of the design group were G. G. Golovintsova and A. S. Gvozdeva while L. A. Pchelin and V. F. Berglezov were the primary design force for the combustion chambers. They reviewed the previous design and came up with a number of original solutions both for the design and for technology. N. I. Novikov had acquired some skill in designing various types of throttles and he developed the first air pressure reduction valves and the check valves. Experiments were conducted on igniting the propellant components during engine firing. This was the beginning of the development for the first engine which received the identifier RE-1 [rocket engine].

It was under development from the spring of 1944 until October when it was submitted for State Bench Tests. It passed them with outstanding marks. A total of two engines were used during development. Engine No 3 was submitted to the State Commission while Engine No 4 was flight tested. The program for the State Bench Tests made provisions for ten firings without approaching the engine. This requirement was strictly accomplished. During the entire test period, nobody approached the engine with a wrench. It worked for the prescribed time and then was disassembled and studied for defects. None were discovered. The measured performance confirmed mission accomplishment. The designers celebrated their victory; the group was given a large monetary award and, a year later, everybody in the group received orders and medals. At the same time, governmental decorations were awarded to the designers of the liquid-propellant rocket engine--Glushko and Dushkin, collaborators to the Experimental Design Bureau.

With the RE-1 engine on it, the BI carried out a series of flights. The official document signed by Chief Designer Bolkhovitinov stated that the engine operated steadily during flight testing. The transition from one regime to another proceeded smoothly following the engine control quadrant. The automatic engine start was accomplished without failure and the transition from the starting regime to operational regime was smooth. Engine control, the electrical circuit, the automatic equipment and power system units functioned in a satisfactory manner. The engine performance obtained during the tests met the design performance as did the data obtained during the State Bench Tests.

At the end of the war, the German Jumo-4 and BMW-003 turbo-supercharger engines were brought from Koenigsberg. In the Soviet Union, A. M. Lyul'ka had already been successfully working on these kinds of engines for many years and the captured engines only confirmed the feasibility of his work. It became clear that aviation would have to be based on the turbo-supercharger engines. Without having time to develop at all, manned platforms with rocket engines now had the ground knocked out from under them. But, Bolkhovitinov's group would still build its second aircraft with a liquid-propellant engine. In the spring of 1944, a new Scientific Research Institute was organized with the facilities of Bolkhovitinov's enterprise and the Jet Propulsion Scientific Research Institute. Bolkhovitinov became the institute's scientific manager and left design work; the second rocket-propelled aircraft (with the 02 identifier) was built under the supervision of I. F. Florov. The engine division of Bolkhovitinov's plant, which had been designated an Experimental Design Bureau for the new Scientific Research Institute, would build the engine for this aircraft. Of course, the RE-1 engine could have been used on the new aircraft but the engine specialists had a taste for their work and were not able to restrain themselves from modernizing it. Although they intended to develop something else, something in the area of pure rocketry, they essentially developed a new RE-1M reusable aircraft engine. The development of it stretched out. Not until July 1946 did it undergo bench tests, this time without any pumps, and in December the 02 aircraft with the RE-1M engine made its first test hops.

In spite of the seemingly outstanding performance of the RE-1 engine, there was room for modernization. It was heavy (almost 100 kg), complex and expensive; it had too many components in the automatic equipment, an extremely complicated electrical circuit and a total burn time which was not very high for an aircraft engine--a total of 33 minutes--and the pressure for supplying the propellant was too high--43.5 atmospheres with a pressure of 16 atmospheres in the chamber. The RE-1M appeared after the improvements: the weight was reduced, the design was simplified, total burn time was increased and the supply pressure was reduced. Only the specific impulse did not increase for some unknown reason. The figure 196 was in the report on the plant tests, that is, the specific impulse of the RE-1M had declined by several units. Perhaps it was necessary to pay for the harvest they reaped with these units? The designers believed (evidently, correctly) that this was necessary.

In the fall of 1944, the Experimental Design Bureau began to define its current engineering course and its prospects for the future. It became more and more clear that its prospects did not lie in reusable engines but in single-use engines. In accordance with this, a search got underway for solutions which would meet this mission. Therefore, other work was conducted concurrently with the development of the RE-1M: work on developing a promising, simplified, welded engine with a thrust of 1,250 kg (the U-1250). This job entirely absorbed all the group's creative efforts.

In the summer of 1944, they were brought a pile of twisted iron intermixed with electrical wires and flattened boxes of tightly-packed, glass-insulated electrical equipment. These were fragments of a German V-2 brought from the liberated part of Poland which the fascists had previously used as a range. For two months, the conference room was transformed into a workshop-laboratory where the designers restored Hitler's secret weapon using the broken pieces of the sheet iron and aluminum and the smashed units and cathode tubes (like the paleontologist Georges Cuvier who restored the skeleton of a brontosaurus bone by bone). They were successful. The team--made up of I. F. Florov, K. D. Bushuyev and others--established the missile's ballistic characteristics, its purpose and geometry. The designers even made overall blueprints, made a hydraulic diagram of the power system and studied the control system. After this, the Experimental Design Bureau's engine specialists had an even stronger desire to develop their own rocket engines which they conceptualized as the simplest in design, single-use and non-adjustable. Work on a simplified design of a single-use engine began immediately after the RE-1 was developed.

By June 1945, they were able to get approximately 2 liters of an liquid igniter from Glushko. This trifling amount did not make it possible to develop the firing work as required. They were only able to establish that the fine liquid igniter did not ignite in the air, that a screen soaked in the liquid igniter was required for ignition and that a detonation did occur when the liquid igniter came into contact with an acid inside a closed chamber. The experiments ended with the detonation of an injection head in one of the chambers; due to the lack of pressurization in the diaphragm valves in the chamber, the components were mixed. Later, there was a break in the work on the U-1250, which extended to December 1945. This break was caused by a trip to Germany by a group of supervisors. After this trip, it was clear to Isayev that there was no reason for us to copy the design of the German engines; our models were more promising. After spending 3 1/2 months there, Isayev left Germany in order to continue the job he had already started. The other members of the group left for home behind him. By the end of 1945, everybody had returned home and began working on the development of the U-1250 with renewed force.

The next stage of the Experimental Design Bureau's work was of special importance. This stage confirmed our general engineering course by guaranteeing future output of series engines and it developed a firm reputation for the Experimental Design Bureau. The external environment had a large effect on the development of the general course, new traditions and the development of our school. If the Experimental Design Bureau had had good production facilities at its disposal, if it had provided its best employees with the opportunity for reliable series production and if the employees had been trained at good plants with a high state of the art in technology, our designs probably would have been different. But, they had an extremely small number of general-purpose machine tools, make-shift types of welding at their disposal; they had difficulties with forging and did not have any casting at all, not even the simplest type. Each production order was restricted to the minimum and accomplished late. Therefore, the designer's first task in an Experimental Design Bureau like this was to achieve maximum simplicity and to develop a design which would not require any special equipment, which could be made from the materials at hand and which would not require the start-up of any new industrial processes. Simplicity in production was supposed to lead to operational reliability. Concurrently with the maximum simplification of the units themselves, they tried to reduce the number of them. Every superfluous link or blockage was considered a mortal sin. Each unit "was drained" to the maximum extent and simplified to a primitive level. This is how the first designs were developed and this is how the traditions were developed, traditions which were cultivated throughout all the subsequent years of the Experimental Design Bureau's history in spite of the continual growth in production capabilities and the increasing concentration of new industrial processes.

Although its acquaintance with the captured equipment did not throw the Experimental Design Bureau off its design policy, which had been selected before the trip to Germany, the knowledge of the German equipment did expand its horizons and force it to look at many things in a different way. One of its components could have been copied immediately: the hypergolic propellant. Isayev did not intend to use this synthetic liquid as the primary propellant; he maintained the point of view which we had had for many years: the primary propellant must and should be a petroleum derivative, kerosene, and not synthetic. It would be reasonable to use the hypergolic propellant as a liquid igniter.

Development of the cooling system got underway, that is, work on the engine's injection head. While designing the engine head for the U-1250 in the spring of 1945, they proceeded further in the direction taken in the RE-1M engine and increased the number of injectors, bringing them up to 120. The first firings of this injection head in an uncooled chamber demonstrated an extremely high average thermal flux. Uncooled, thick-walled chambers were used to measure them. The cylindrical part of the chamber consisted of several circular sections connected by flanges so that chambers with different lengths could be put together. Threaded seats were made along the circular cross-sections and along the resulting sections; "calorimeters"--small, steel cylinders with thermocouples welded to the outer side--were screwed into the sections. The experiments in an uncooled chamber made it possible to immediately obtain a curve for the thermal flux along the length of the chamber in the nozzle for various resultants characteristic of the injection head being tested. This method was rather precise and it immediately provided a picture of the performance.

By the spring of 1946, there was a second increase in the work on the U-1250 engine. In the winter, the production capabilities were extremely limited and all the parts were made with our own resources; after the assignment was received from the government to develop this engine, the job evolved completely and the high tempo did not drop off in the future. The engine design was completely reviewed again. A complete kit of experimental engine components was produced and put into production; these components made it possible to test a series of versions. While the new parts were being manufactured, we were able to develop the firing work on the articles which had been made in the spring and summer of 1945 and which had been improved during the winter.

However, after testing the new parts, it was necessary to completely redesign the engine again. Only the new version of it successfully passed all the preliminary tests. Meanwhile, after becoming the scientific manager of the scientific institute he set up, Bolkhovitinov established a division which would pursue scientific work on liquid-propellant engines. Scientific researchers from the Central Boiler and Turbine Institute--G. F. Knorre, A. A. Gukhman and L. A. Vulis--were hired for the job. Their in-depth knowledge in the field of combustion and heat transfer helped the designers. However, Bolkhovitinov's organization at the Scientific Research Institute laboratory was detrimental to the Experimental Design Bureau since I. I. Raykov and G. G. Golovintsov transferred to it. The Experimental Design Bureau lost its chief tester and one of its theoreticians. Other people were promoted; the work process did not slow down and the U-1250 was developed rather quickly; it became the basic model for an entire family of engines. It was the first chamber design with composite casings. Since that time, this principle has become firmly imbedded in domestic engine production.

In September 1946, the U-1250 passed the plant tests; this brought a great deal of moral satisfaction since everybody understood the importance of the U-1250 for subsequent designs. After all, the U-1250 had resolved the problem of chamber stability and it opened up the possibility of increasing the thrust in a single unit. New articles, similar in design, could now have a broad thrust envelope. The Experimental Design Bureau subsequently made progress in the search for the best power system configuration and it established standard designs for units of it. By the end of this period, flushed with a certain amount of success, the designers began to state that they had already learned how to make rocket engines. Moreover, the U-1250 was not tied down to a definite article; it was made "for the soul" and was educational in nature. After all, in 1946, there actually weren't any articles of space rocket equipment. Rocket experimental design bureaus had not yet been set up. However, there was a feeling that they were just over the hill. Everybody got ready for the future, large orders which Isayev believed would encompass all classes of rockets. The U-1250 combustion chamber made it possible to establish an engine system which, in their opinion, would provide power for rockets in any class more economically than the German systems and would also provide greater reliability and be used more on an operational basis.

The Experimental Design Bureau had not only established its policy in rocket engine production but it also began to promote it. Here are the primary principles of this policy: 1) Propellant. Of course, there was no special chemical, only kerosene and nitric acid. A special chemical was only used for ignition. 2) Propellant flow. There was only pressurized flow. It was the simplist and most reliable. Rockets with a completely suitable weight were obtained with it.
3) Engines. At that time, the concept engine essentially embraced a single chamber. The Experimental Design Bureau had developed a chamber with a flat injection head with centrifugal injectors reasonably located on it. The injectors ensured a low "conductivity" in the layer near the wall; the conical chamber with its connected sections (the most important

thing was precisely the connected sections, the chamber's totally welded design) could be produced in a single type for the entire thrust envelope possible at that time--from 400 kg to 9 tons. In an industrial sense, these chambers were elementary or, as they used to say, they were easy to make in any workshop. 4) Accessories. The resuable or single-use designed-in units of automatic equipment were simple, reliable and made it possible to implement the designs for rocket propulsion systems--both single regime, and controllable ones with follow-on firings. This was the engine specialists' creed in 1946. They did not suspect a lot at that time; the above-mentioned propositions were partially repudiated by future developments in rocket engineering. But, others were the foundation of domestic engine production and it is still based on them up to the present.

On 17 July 1946, before the official hand-over of the U-1250, a document which was touching in its naivite and openness was sent to M. V. Khrunichev, Minister of the USSR Aviation Industry. In this document, the designers wrote about their achievements in developing new models of liquid-propellant rocket engines and they provided a report on the chamber for the U-1250, the first totally welded chamber made from sheet metal with connected, spot-welded sections, which they had developed. This chamber was a qualitative leap forward in liquid-propellant rocket engines since it made it possible to manufacture thin, light inner casings due to the rigid connection between the sections. In turn, this made it possible for unlimited reheat of chambers for pressure and thrust. Based on the U-1250, a number of chambers with a thrust up to 9 tons were designed and estimates of the weights and ranges of rockets equipped with them were cited. The designers requested assistance in building benches and production facilities for the Experimental Design Bureau.

The letter did not have the expected impact. Soon afterwards, the branch of the Scientific Research Institute where the Experimental Design Bureau was based was resubordinated to another Experimental Design Bureau; the former bureau, was a foreign body in the new organization. By that time, Bolkhovitinov had left to direct the aircraft design department at the Air Force Academy. M. V. Keldysh, the future president of the USSR Academy of Sciences, became the chief of the Scientific Research Institute. The institute began to develop more and more along the lines of pure science in the field of gas dynamics and the processes within liquid-propellant rocket engine chambers. Experimental design work was not promising at the scientific institute. Therefore, the institute was not able to provide the Experimental Design Bureau the support it required.

In order to remain at our previous location, we had to get the new chief designer interested in our presence. This is what we did. We very willingly accepted an order to develop a propulsion system for a flying model of a supersonic aircraft. The work proceeded in the same shop with the same aircraft designers with whom the engine specialists had worked previously; only the management changed. The U-400-10 engine (with a thrust of 400 kg and a nozzle altitude tolerance of 10 km) had already passed plant bench tests in Februay 1947. Somewhat later, the entire propulsion system was completed and the flying model began operating at the range in the same year. Its flights were of value to transonic aerodynamics at that time. There were no major failures in this job. Literally from the first try, everything proceeded smoothly. N. I. Novikov worked on the system's improvements and its range operations. The design of the automatic equipment systems belonged to him. The snapshots which were preserved provide a clear representation of this work. Later, in the beginning of 1948, Keldysh submitted Isayev for the State Prize. This was the first State Prize in the USSR for this kind of engineering.

Meanwhile, in 1946, the Experimental Design Bureau had started a new job: an order was received from the Air Force for a rocket to assist aircraft take-offs. The assigned task was difficult: a RATO [rocket-assisted take-off] unit with an impulse of 30,000 kilogram-seconds (1,500 kg for 20 sec) with a weight of 100 kg (empty) and 300 kg (take-off) which had to be dropped by parachute after take-off, reloaded and used again (up to 60 times). Work on the RATO-1500 stretched out for a long time. Of course, the combustion chamber turned up immediately: the U-1250 chamber was already a very good foundation for it. But, the developmental work was labor intensive since it was related to flying.

At the end of 1945, a group of officials from one of the people's commissariats had arrived at the Experimental Design Bureau with a proposal to develop an engine for a naval torpedo. This proposal was accepted willingly. Again, they developed an engine with a thrust of 1,400 kg without any difficulty and designed the propulsion system. On 18 July 1946, the engine was fitted with impulse flasks for five seconds of operation, capped with a sheet of rubber, tied to a rope with the nozzle up, lowered into the fire pond and fastened down in it at a depth of approximately one meter. When the engine fired, a brief churning, given off by the firing regime, was noticeable. After the second command pulse, which provided full propellant consumption, the water behind the engine swelled up to a height of 2.5 meters and a length of 15-20 meters. The water was black from the sediment raised from the bottom. The characteristic noise of the engine could not be heard. Eight seconds later, the swell subsided, the water became calm and the system was extracted. The rubber hood had been discarded but it was still in one piece and was hanging on the rope to which it had been fastened. It was used a second time. The follow-on firing completely reproduced the entire picture. No changes were discovered in the engine or the system.

In the fall of 1946, Isayev had his first conversation with people representing "big" rocket engineering. After all, the RATO unit, the flying model and the naval torpedo could not be considered "big" rocket engineering. The organizational work on developing production of rocket equipment was concentrated in the Party Central Committee. Isayev was summoned to the Central Committee and the Experimental Design Bureau was assigned the development of a kerosene-nitric acid engine for an anti-aircraft missile. This determined the destiny and field for the Experimental Design Bureau's near future. The Experimental Design Bureau had to relocate to an institute which had been set up in order to develop the engines with this design for the guided surface-to-air missiles which had been developed at the institute.

A year passed before the first group of researchers moved to the new location. An experimental shop had been set up there but there were still no benches and they had to maintain their old facilities until the spring of 1948. The old facility only ended its existance after a new eight-ton rocket shook down the roof of the neighboring hangar where the assembly shop was located. Before that, the director of the new Scientific Research Institute and the chief designer for surface-to-air guided missiles and his deputies visited the plant. The director was struck by the piteous sight of their facilities and he assured the Experimental Design Group that he would build a palace for them on the institute's territory. The palace was later enclosed by an earthen mound into which cannons were fired for many years. Near this mound, the Experimental Design Bureau began to build its first bench in its new territory; the bench was made out of a sort of artillery tower which they drug out of a ravine and out of iron which was scattered about.

Thus, their previous work continued. A propulsion system was developed for the naval torpedo and five engines for it were delivered to the customer who coordinated further production of them. They set up a bench for them at the old gas plant and trained test personnel. During sea trials, the torpedo travelled at an unheard of speed but did not go very far; because of this, it was not put into service. The development work on the RATO unit for the RATO-1500 proceeded for a very long time. It was endlessly "crashing" into the ground or the sidewalks during tests. A batch of 100 units were made later (in 1950) at the institute and delivered to the AF. But, they did not earn any fame for themselves with this item either since the success in producing turbo-supercharger engines reduced the requirement for it and it did not go any further.

Then, an order was received for a naval rocket engine from another organization. This article lived a little longer. The engine specialists handled their part right away but the flight tests took several years and, in the end, this article sank. They were doing more interesting work at that time with the National Council of the Scientific Equipment Engineering Society (NCSEES). A design bureau had been set up within this public organization; its goal was to make a surface-to-air guided missile. The enthusiasm of the young people who had gone this route attracted skilled people from aviation and people who were knowledgeable in electronic support and guidance matters. With a great deal of willingness and, as before, extremely quickly, the Experimental Design Bureau developed a two-ton engine and a propulsion system design for the NCSEES. However, this job could not be completed without a facility. Other jobs followed this one (not counting the primary job which brought about the Experimental Design Bureau's transfer to the Scientific Research Institute). But, this was already after the Experimental Design Bureau's move to the new Scientific Research Institute. Actually, during the last year spent in their old area, the Experimental Design Bureau did not lose its engineering growth. During that year, in addition to expanding its contacts and distributing "its" equipment on a widespread basis, it was able to make something basic.

As strange as it may seem, it was in the field of chemistry. In spite of the simplicity of the designs developed for the one-time propulsion systems, the designers continued to be bothered by a nagging doubt. They were not able to reconcile themselves with the requirement to provide two sequential impulses for firing. The current firing components--xylidine and a 4-percent solution of ferric chloride in nitric acid--required a consumption for firing which was 25-30 percent of the propellant load. This is why it was necessary to separate the forward cylinders, make the compressed air drive more complex and install a timer. It was sickening to do things like this! It was necessary to achieve a "full-flow" start at any cost. Beginning in 1946, chemists began to visit the Experimental Design Bureau. When they arrived, they heard conversations like this: "A synthetic hypergolic propellant is a luxury. Kerosene is sufficient. But, give us a good pair of igniters which will make it possible to do a 'full-flow' start." The chemists watched closely, stared hard and got ready for something but, meanwhile, there weren't any results.

To study starting problems, the Experimental Design Bureau made a special unit which they called the "the chemist's chamber": two propellant cylinders, a twin component triggering-shut off valve, a monolythic injection head with screw-in injectors to which the thick-walled chamber and the nozzle were attached with four calibrated bolts. The small cylinders were filled one-third full with the components being studied. Compressed air was fed to the small cylinders; then the valve was opened abruptly. At this point, the chamber either stayed in place or flew into the sand after breaking the bolts. If the bolts didn't break, that was good; if they broke, it was bad! This was their engineering. But, after all, inertia-free pressure meters did not exist then.

A lot of things were tested in this unit until the M-50 mixture appeared--a marvelous liquid oxidizer which guaranteed a "full-flow" start. The M-50 mode looked like this: at first, a gray smoke was silently discharged. A second later (the time depended upon the amount of the mixture), the noise increased smoothly and the gray smoke grew brighter before your eyes and changed into an actual high-speed flame with Mach rings. Not for a single moment did the pressure in the chamber exceed the value for that mode (they found out about this later when they began to use inertia-free pressure meters). This was a truly brilliant achievement! It is surprising that it was a purely home-grown invention which the chemists did not participate in. M-50 began to be widely introduced into all propulsion systems. Not a single bench start was carried out without the mixture. The mixture continued in existence for many years. Its importance only began to decline with the transition to a pump-feed which guaranteed a smooth increase in consumption as the pumps opened up. But, the mixture continued to be used on the benches during the development of combustion chambers. The unit for mixing it was only removed from the bench in 1958. For ten years, M-50 reliably and faithfully served rocket equipment.

A short time later, the designers "began to develop an itch" again. They began to invent an igniter propellant which could get along without the igniter oxidizer--the mixture. This time, with assistance from the chemists (the propellant specialists), this propellant was invented based on the sodium metal, carbon tetrachloride and other additives: a so-called "stew." When cooked with fresh ingredients, it handled the job in an outstanding manner. However, it was not stable and did not go into use. There were also other suggestions from the chemists: activators in the form of cloth impregnated with a special compound (the so-called "foot-cloths"), chemical throttles--cartridges with a hole in the line washed by the oxidizer--and other "clever tricks." But, nothing came of them, and later, we were still able to make it without the mixture in items with a pressurized feed system--using a mechanical, automatic throttle. This happened in 1952.

In completing the section on the Experimental Design Bureau's "ancient history," it would be appropriate to evaluate its results by providing an overall rating for the activities of this small group of engineers during their first years of joint work. What kind of resources did they bring to the new Scientific Research Institute? They had had to learn to make extremely simple and reliable one-time, single-regime propulsion systems. They had some outstanding bench equipment. They had firmly resolved not to permit synthetic, hypergolic propellants in Soviet rocket equipment and they proved the feasibility of accomplishing the mission with simple petroleum derivatives. They developed a number of propulsion systems which made use of the above principles: systems for the flying model of a transonic aircraft, for a naval torpedo, for an air-to-surface naval rocket, for the NCSEES surface-to-air missile and they made the RATO unit for aircraft.

What didn't they know yet? Primarily high frequencies. The parameters of the current chambers had not pushed them up against this "wild animal" which had been scaring engine specialists for many years now. In complete ignorance of the danger awaiting them, they had no doubts that they could make a chamber of 10, 15 or more tons in principle just as simply as a two-ton chamber; they believed the entire problem was one of production capabilities. Therefore, with a light heart, they drew up an 8-ton chamber and made the first models in the new experimental shop at the Scientific Research Institute. Then, the previously hidden "monster" roared in such a fashion during the first firing that the glass flew out and the roof of the assembly hangar was almost shaken off. The "animal" chased the Experimental Design Bureau out of its old territory and followed it to the Scientific Research Institute. How they looked for an approach to the "animal" and the bait they left for it while trying to cajole it and gain its position is a special topic.

What could the resources accumulated by the Experimental Design Bureau in its old facilities support? A lot. Surface-to-air, air-to-air, air-to-surface, naval air-to-surface and even tactical surface-to-surface missiles with 100, 300 and 500 kilometer ranges. Why was it that up until 1952, the Experimental Design Bureau was not able to boast about the fact that it had made a practical contribution to the country's rocket equipment and had, thereby, justified its existence to the motherland? The problem was not with the Experimental Design Bureau or with high frequencies. Unfortunately, missiles and rockets are not just made from engines and tanks. To obtain missile and rocket systems, radio electronics, gyroscope systems, high-quality electronic equipment components, telemetry, ranges, rocket and missile personnel and "ground crews" are required. A lot had to occur in industry before it was able to make everything which was required. Due to the selfless labor of a small group of people, "engine affairs" were ahead in the sense of developing models and in the sense of the level of knowledge. But, harvest time had still not arrived.

The Experimental Design Bureau's designers were acquainted with certain models of German rocket equipment. But, they did not proceed to reproduce them. The captured equipment's very heavy chamber and large turbo-pump unit were not to their liking. It was precisely due to the influence of this Experimental Design Bureau that not a single German rocket, besides the V-2[4], was reproduced in the USSR. Domestic rocket equipment outfitted with engines designed by this Experimental Design Bureau were used; they did not have anything in common with foreign systems. So, we have arrived at the most important stage of this Experimental Design Bureau's activities, the bureau which raised the curtain on the period when the shapes of engines for space ships were already vaguely emerging on the horizon.

FOOTNOTES

1. Aleksey Mikhaylovich Isayev (1908-1971), prominent rocket engine specialist, one of the founders of domestic rocket engine production, doctor of engineering sciences, Hero of Socialists Labor, project manager for developing a series of engines for the manned space ships, Vostok, Voskhod and Soyuz and the unmanned space probes Luna, Mars, Venus; Lenin and State Prize Winner. Pages with particularly specialized content are omitted here from the memoirs he wrote. The author writes about himself in the third person.

2. The originator of the overall idea for a rocket-propelled fighter interceptor was S. P. Korolev who was in charge of the project for experimental rocket-propelled aircraft which was conducted beginning in 1931 by the Jet Propulsion Study Group and beginning in 1936 by the Jet Propulsion Scientific Research Institute.. The ground work for the idea of a rocket-propelled interceptor was provided in 1938 in the article "Summary of a Report on Subject 318: Scientific Research on a Rocket-Propelled Aircraft," which was published in the anthology, "Pionery raketnoy tekhniki. Vetchinkin, Glushko, Korolev, Tikhonravov," (Moscow, 1972). Although the idea of developing a rocket-propelled interceptor arose with A. Ya. Bereznyak independently of the Scientific Research Institute's work, successful progress in this work and, specifically, flight testing of the RP-318-1 rocket glider with a liquid-propellant rocket engine in 1940 created a favorable environment for making the decision to develop a rocket-propelled interceptor at V. F. Bolkhovitinov's Experimental Design Bureau.

3. L. S. Dushkin's group was part of the Jet Propulsion Scientific Research Institute and it developed the liquid-propellant rocket engine for a rocket-propelled interceptor; the work which was begun by S. P. Korolev on developing this interceptor was continued at this institute.

4. In spite of its relative complexity, the V-2 was quickly reproduced as the R-1 rocket by the group under S. P. Korolev's supervision and it played a secondary role as a training vehicle. While it was being manufactured, tested and put into operational use, the USSR mastered the production technology and accumulated experience working with large,

oxygen-fuel ballistic missiles. But, just a year later, the R-1 began to be replaced by a missile designed by S. P. Korolev with a great deal higher in-flight performance.

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BRIEFS

REACTION FORCE FORMED--A few days prior to the [initiation of the] Soviet airlift to Kabul, the following information reached the French [intelligence] services: a Soviet quick reaction force able to be sent to any point of crisis is now being trained. Its members are taken from units of the Red Army Guard; the average age of these professionals is 22. [Text] [Paris VALEURS ACTUELLES in French 31 Dec 79 p 13]

NEW COMBAT VESSELS--The USSR is building the largest surface combat ships it has built in 20 years, four nuclear-powered cruisers of 30,000 tons and a 60,000-ton nuclear-powered aircraft carrier, the first one ever for the Soviet fleet. The fleet also has a new nuclear-powered submarine, the Alfa, which runs faster than the American submarines and can dive to 600 meters, twice as deep as the American submarines. This performance is made possible by making the hull of titanium, a stronger lighter metal. [Text] [Paris VALEURS ACTUELLES in French 31 Dec 79 p 13]

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