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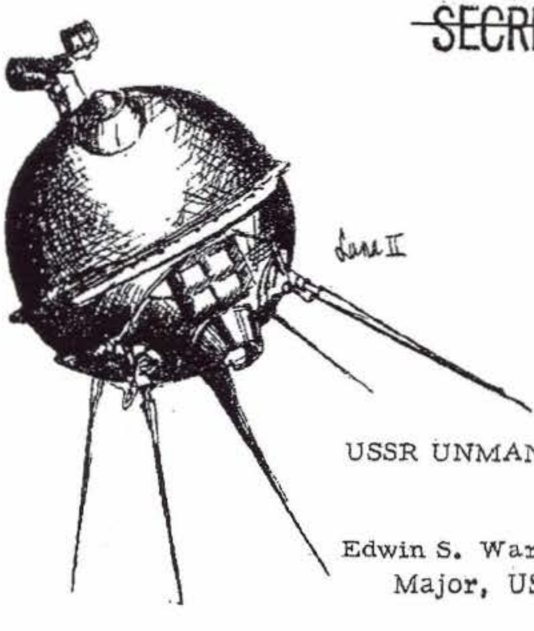

USSR UNMANNED SPACE PROGRAM

Edwin S. Warrell, Jr.
Major, USAF

This article is adapted from a lecture presented by the author at the Air University Institute for Professional Development's Space Systems Course.

INTRODUCTION

On 4 October 1957, the Soviet Union opened the space age with the launching of Sputnik 1. Sputnik 1 was a small satellite: less than 23 inches in diameter, weighing less than 200 pounds, and it stayed in orbit only 92 days. Nevertheless, Sputnik 1 was an artificial earth satellite; it was the first one launched, and it was launched by the Soviet Union. From this rather modest beginning, Russia has developed a large and comprehensive space program. It is a space program that presents a potential threat to the security of the United States and the rest of the free world.

LAUNCH VEHICLES

Although the first Russian satellite was small, the launch vehicle used to place it in orbit was large in size as well as capability — particularly for 1957. The specific configuration of the Sputnik 1 launch vehicle has never been released. However, it was apparently based on the first Soviet operational ICBM, the SS-6, with two strap-on boosters. With this configuration, known as the SL-1 launch vehicle, the Russians demonstrated a capability to place more than 1000 pounds

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into orbit. They added two more strap-on boosters in 1958 and came up with what is called the SL-2 launch vehicle system. This system was capable of placing a 3000-pound payload into earth orbit. The SL-2 was used only once by the Russians, but it became the heart of an entire family of launch vehicles that are still active today and have been the mainstay of their space program. (Figure 1)

This family of vehicles began to appear in 1960 when the Russians launched Sputnik 4, using the SL-2 plus an upper stage called Lunik. This modification, known as the SL-3, has been used more than any other launch vehicle in their program.

Also during 1960, the Russians altered the SL-3 configuration by replacing the Lunik stage with a higher-thrust upper stage called Venik, plus a fourth stage to provide them an interplanetary capability. This system, the SL-6, has since been used in the lunar and interplanetary programs as well as for some unique earth orbit applications.

During 1963, the Russians required a launch vehicle for a 12,000-14,000-pound payload, so they modified the SL-6 by removing the fourth stage and came up with what is called the SL-4. The SL-4 is now the workhorse launch vehicle of their manned and military programs.

The Russians made two more modifications to their standard launch vehicle family in 1963 and 1965, but these launch vehicle systems, known as the SL-5 and SL-10, have been used only sparingly. The SL-5 uses the Lunik stage plus a fourth stage payload combination. The fourth stage payload combination provides the final propulsion capability for orbital injection as well as a capability for orbital maneuvers. Similarly, the SL-10 has an in-space propulsion capability. This system employs the basic SS-6 space booster/sustainer with a third stage payload combination called Polyot. The Polyot stage enabled the Soviet Union to claim the world's first maneuverable satellite.

The development of the SS-6 space booster/sustainer combination gave the Soviet Union an early lead in launch vehicle capability and enabled them to support a wide variety of space missions. However, even in its earliest configuration, this system was not adaptable for the economical launch of small scientific satellites. They solved this dilemma with the development of the SL-7 in 1961.

Relying again on a proven ballistic missile as a lower stage, the Russians modified a medium range ballistic missile (MRBM) by adding a relatively small second stage. This modification became the SL-7 launch vehicle with an economical payload capability of 800 pounds in low earth orbit.

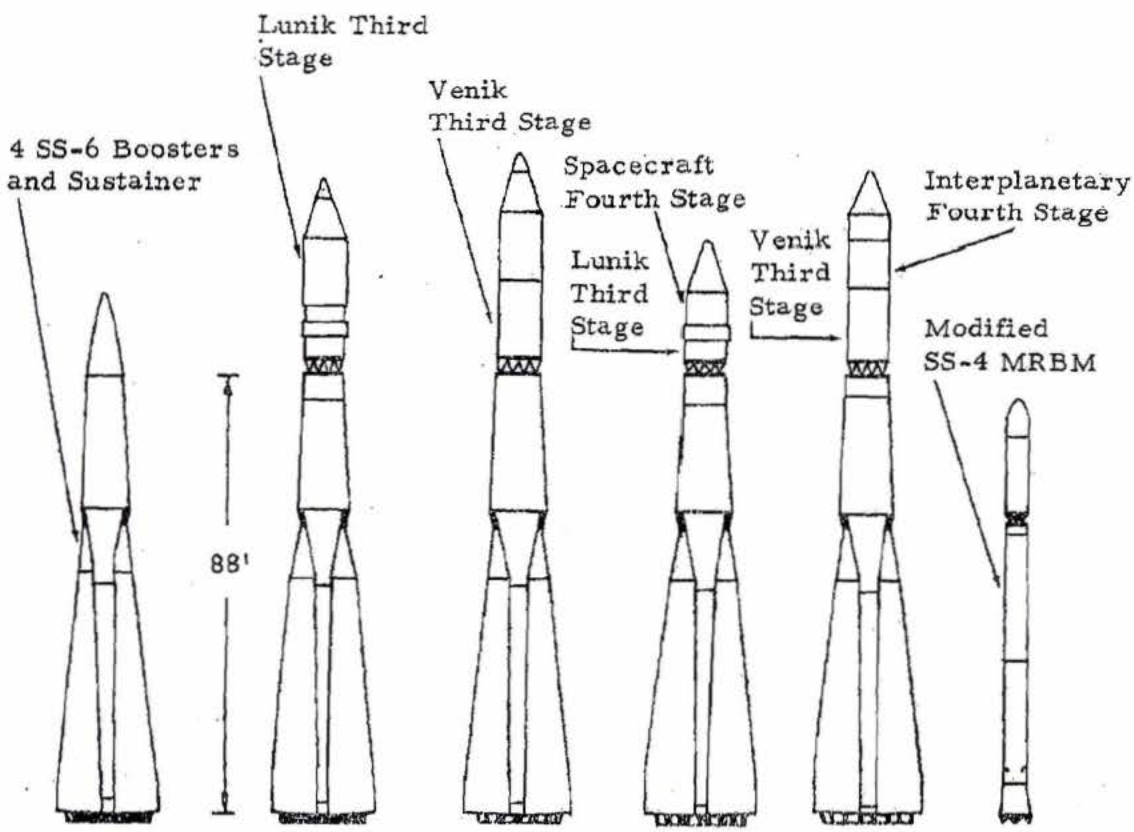
A larger two-stage tandem launch vehicle is the SL-8. This system, which appeared in 1964, again uses a modified ballistic missile for the first stage. For the SL-8 the Russians took an SS-5 IRBM and coupled it with a specially designed upper stage. This combination is capable of placing 3000 pounds in a near earth orbit and has been used primarily as a launch vehicle for multiple payloads.

In 1965, the USSR demonstrated what can be called their first "quantum jump" in launch vehicle development. On 16 July 1965, they launched Proton 1, which weighed 27,000 pounds. The Proton launch vehicle has never been displayed by the Russians, but it apparently is a two-stage tandem vehicle with both stages between 40 and 50 feet long. The lower stage has a greater diameter than the upper stage; 25-30 feet diameter as compared to a 14-15 foot diameter upper stage. Most estimates place the total earth orbit payload capability of this system, now called the SL-9, at 30,000 pounds. The SL-9 has been used only in launches of Proton vehicles and may not be designed specifically as a new operational launch vehicle. Rather, it is likely that the SL-9 is a building block in the development of an entirely new family of launch vehicles. Following the SL-9, this development cycle produced the SL-12.

The SL-12 provides the Russians with their greatest operational launch vehicle capability. This system was first used in March 1967 with the launch of Cosmos 146. Estimates on the weight of Cosmos 146 have varied from 40,000 to 60,000 pounds, but its generally accepted capability is approximately 50,000 pounds in near earth orbit.

The SL-12 appears to be the SL-9 with two additional upper stages, bringing the total height of the vehicle to between 137 and 167 feet. This vehicle has been used 12 times by the Russians with eight successes, and it is the vehicle that enabled them to complete the first circumlunar flights. It appears capable of launching a 15,000-pound manned vehicle on a circumlunar flight, but it is not capable of handling a manned lunar landing and return mission. Although the SL-12 has a definite operational role in the Soviet space program, it

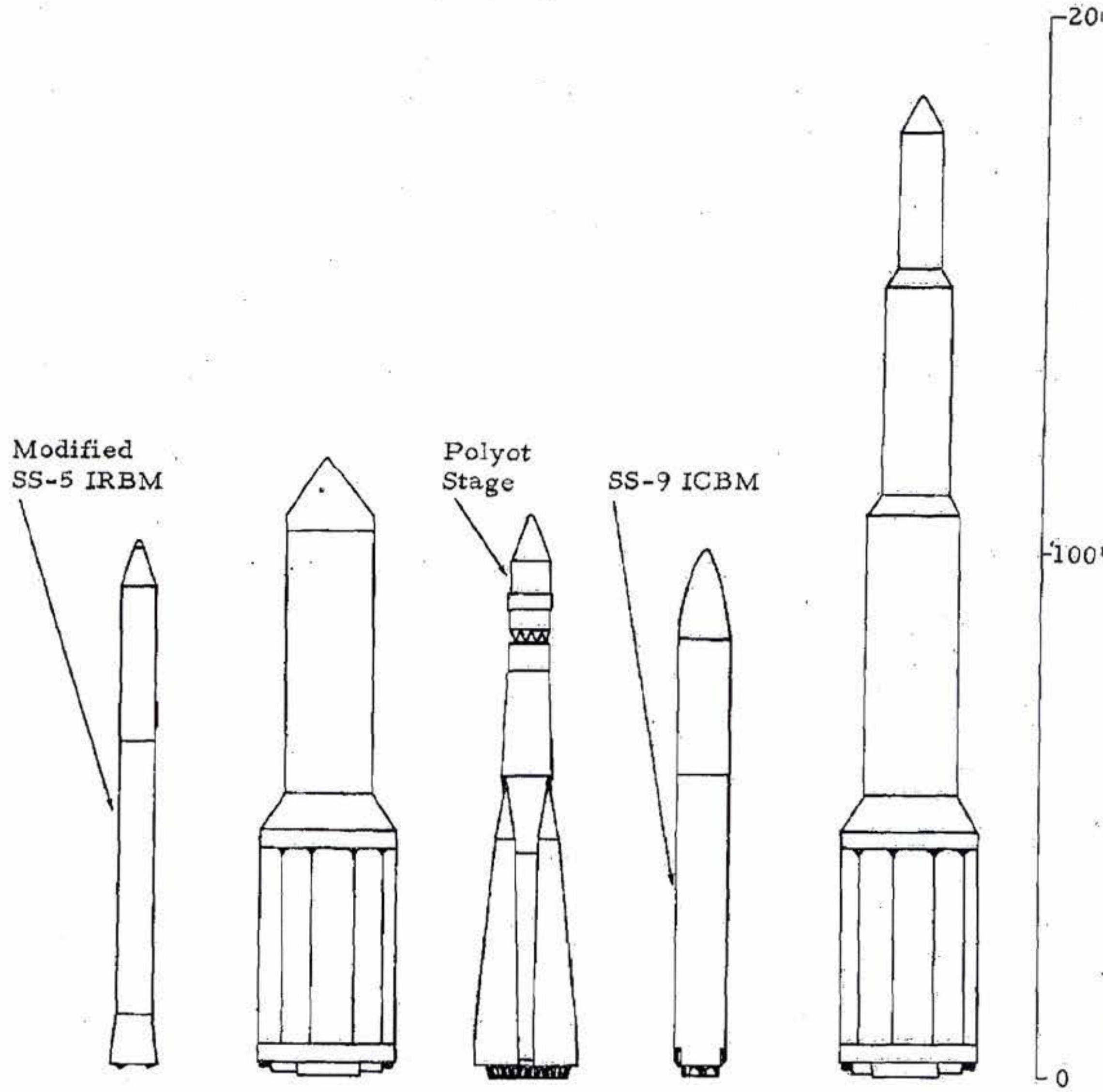
Fig. 1 SOVIET SPACE LAUNCH VEHICLE FAMILY
Source: DIA ST-CS-16-13-68JNT
Space Launch Systems (Trends)— USSR



	SL-1/SL-2	SL-3	SL-4	SL-5	SL-6	SL-7
*	2500-5000	12,000	15,000	7000	16,000	800
**	Early Sputnicks	Early Manned Lunar Cosmos	Manned Cosmos	R&D	Lunar Planetary ComSat	Scientific

* Approx. Payload Wt. 100 NM Orbit

** Typical Missions



SL-8	SL-9	SL-10	SL-11	SL-12
3000	30,000	5000+	7000	50,000
Multiple Payloads	Proton	Polyot	Military	Circumlunar Future

is probably another step in the evolution of the family of large launch vehicles— one of which will no doubt provide a manned lunar-landing capability.

There is one other operational launch vehicle in the Soviet inventory. It has been designated the SL-11 and plays an important role in military space operations. Once again it is a modification of a ballistic missile— the two-stage SS-9 ICBM. By adding a 23-foot third stage the SL-11 gains the capability to place a 7000-pound satellite in near earth orbit. It was this system that the Russians used in the highly publicized Fractional Orbit Bombardment System (FOBS) tests postulated in 1967 and 1968.

The Russians have developed a broad launch vehicle capability in support of their space effort. The approach they have used has been for the most part evolutionary, based upon proven ballistic missiles. All but two of their launch vehicles (SL-9/SL-12) have evolved from this source. They have not, to date, developed a launch vehicle that is competitive with our Saturn 5. Because of this they do not have the capability to conduct an Apollo-type lunar mission. There have been, however, a number of statements in the open press that the Soviets may be developing a very large launch vehicle which will be at least competitive with the Saturn 5 capability if not greater. It appears to be well within the Soviet technical ability to do just this.

There is a reported buildup of a new rocket complex at the Tyura Tam launch facility that consists primarily of a huge assembly building. The building is 800 feet long and has a bay section about 190 feet high with 120 foot doors. The total area of the building encompasses 495,000 square feet, which is larger than our comparable facility for Saturn but not as high. A vehicle assembled in such a building would probably be about 100 feet high and at least 40 feet in diameter. It would either be coupled with upper stages outside the building or assembled horizontally inside the building.

Most of the estimates for the final configuration of the vehicle envision the SL-9/SL-12 as an upper stage. The complete postulated system has been called the SL-X, and there are a number of feasible combinations of propellants which will provide a rather large spread in payload capability. This payload capability is generally estimated to range between 300,000 and 500,000 pounds in low earth orbit. Even on the low side, this would be a greater capability than we have with Saturn 5, once again placing the Russians in the lead in launch vehicle capability.

Although the SL-X is being developed at Tyura Tam, there are other facilities in the Soviet Union which play a major role in their space program.

LAUNCH RANGES

The Russians use three launch ranges for space missions: Kapustin Yar, near the Aral Sea; Tyura Tam on the Volga River; and Plesetsk, south of Archangel. The first of these ranges to become active was Kapustin Yar (KY). In late 1947 the Russians launched a ballistic missile from KY, but it was not the first facility to be used for launching a vehicle into outer space.

Construction of the second launch range, Tyura Tam (TT) probably began in 1955, when the Soviets began their ICBM program. The first space launch from the TT range was Sputnik 1 in 1957, so although it was the second facility developed, it was the first to be used for satellites.

Their newest launch range, Plesetsk, was not used for space launches until 1966, but it had been used earlier as an operational missile base and troop training facility.

Dr. Charles S. Sheldon, the Senior Specialist in Space and Transportation Technology of the Library of Congress' Legislative Reference Service, makes an interesting comparison of the Russian facilities with our own facilities in the United States. He equates Tyura Tam with Cape Kennedy. These were the first space launch sites for both countries. Each has grown into large complexes which support the manned and deep space missions, and each of them supports a wide variety of scientific and R&D vehicles.

Kapustin Yar, according to Dr. Sheldon, is a combination of NASA's Wallops Island and the DOD facility at White Sands, New Mexico. The Wallops Island comparison is drawn because the Russians launch small space vehicles from Kapustin Yar — primarily routine scientific vehicles, the same use we make of Wallops Island. The

White Sands comparison is based on our suborbital launches from there— an activity also characteristic of Kapustin Yar.

The Plesetsk range is compared to Vandenberg AFB by Dr. Sheldon. Both of these ranges launch satellites of primary interest to the military, both developed later in the space program, both sites are far removed from the other launch facilities, and both sites are used for high-inclination satellites which provide better worldwide coverage.[1]

There has been continued growth at all three Russian launch facilities with additional launch pads and support facility construction still underway.

EARTH ORBITING SATELLITES

As of mid-March 1969, the Soviet Union has successfully orbited 345 space vehicles. Of these 345 space vehicles, the vast majority have been in the near earth environment. The magnitude of effort in this area is so large that clarity requires a further division into subsets of scientific, utility and military threat programs. If we were discussing the United States space program, a breakdown of this nature would be relatively simple. Except for certain military programs, the names of various satellites associated with their missions are clearly stated. This is not the case when discussing the Russian program.

The Soviet Union has placed 271 vehicles in earth orbit that have been designated as part of the Cosmos program, a program that began in 1962. When the Russians began the Cosmos program, they announced a long list of scientific objectives, all of significant scientific value. However, this program better than any other Russian program exemplifies their policy of deception in space activities.

There is indeed a scientific mission associated with the Cosmos series, but there are many other activities as well. Even a cursory analysis reveals that utilitarian-type satellites such as weather and navigation are included in this category, but so are military activities of reconnaissance and space weapon development. The Russians use the Cosmos label for research and development vehicles and even as a guise for precursor or prototype launches of manned space vehicles. Moreover, this program serves as a "coverup" for failures in their space program. The Russians do not like to admit failures in space, hence whenever they launch a vehicle that fails or does not achieve its primary purpose, they label it a Cosmos vehicle on a scientific research mission.

There exists a number of research and development efforts in the Cosmos activity about which little is known. One of these programs is the multiple launch program. This series began in 1964, and it is possible that these have been development tests of communications and navigation systems or even just launch vehicle tests. The vehicles are launched from Tyura Tam by the SL-8 launch vehicle. The precise mission remains unknown today.

Another activity of the Cosmos series is the maneuverable vehicle program. In November 1963, the Russians launched under this program Polyot 1 from TT which the Soviets labeled the world's first maneuverable satellite. Polyot 2 followed in 1964. The maneuvering capability demonstrated by Polyot 2 is comparable to our Gemini efforts one year later. Since Polyot 2 all maneuverable vehicles have been considered part of the Cosmos program.

Despite the multitude of activity that is part of the Cosmos program, there is a significant scientific element. Although few would call it as comprehensive or sophisticated as the United States' research program, it does investigate many of the same areas and in some aspects may even surpass U.S. achievements.

SCIENTIFIC SATELLITES

There are two basic elements or mission groups in the Cosmos scientific series. One of the groups is usually called the Kapustin Yar or KY Cosmos program. It began with Cosmos 1 in 1962 (although there were apparently some unsuccessful attempts in 1961) and is still the principal activity of the Kapustin Yar facility.

The vehicles used in this program are relatively small: three feet by five feet and they weigh between 400 and 800 pounds. Most of the vehicles are launched in an easterly direction from KY, resulting in a nominal 49 degree inclination. This launch azimuth results in a minimum expenditure of energy. The lifetime of the vehicles ranges between two months and two years. They are not recovered but eventually decay as they reenter the earth's atmosphere.

The primary mission of this element appears to be basic research in a wide variety of areas in near earth space. This is supplemented with vertical probes also from Kapustin Yar. During 1968, a major effort of this program was directed toward investigating solar flare activity. Normal activities include the study of electron concentration, radio propagation, and micrometeoroid detection. The Russians have claimed the first orbiting astronomical observatory with Cosmos 215. Although this basic research can be applied as an aid to the development of military systems, the program itself does not appear directly tied to military operations.

The second major element of the Cosmos scientific program is known as Mission Group "B." This element began with launches from Kapustin Yar in July of 1964, in what appears to have been an R&D effort. The program was transferred to Plesetsk in 1967, which indicates an operational capability.

Like the rest of the Cosmos scientific program, the Mission Group "B" satellites are small, nonrecoverable vehicles. The Russians claim they are conducting space research, but they have not released any information obtained by these satellites. It is logical to assume that they are conducting classified research of some nature.

Scientific investigation is not the exclusive province of the Cosmos program. Another brief but successful scientific program was Electron. Four Electron vehicles were successfully orbited in 1964, specifically to investigate the earth's radiation belts.

A final scientific program is Proton, which has had four successful launches between 1965 and 1968. These vehicles were quite large. Three vehicles weighed 27,000 pounds, and the one launched in 1968 weighed 35,000 pounds. The purpose of Proton was to investigate solar and cosmic radiation, particularly high-energy particles. This required heavy shielding, which accounts for the great weight of the vehicles. Perhaps more important than the scientific objectives of Proton was the tie-in of this program to the operational testing of the SL-9 launch vehicle. The success of the SL-9/Proton combination resulted in a very cost-effective means of developing a new launch vehicle system.

Soviet Academician Anatoly A. Blagonravov stated, "The prime mover of the Soviet Union's pioneering space program has been the desire to delve deeper into the mysteries of the universe...."[2] It is true that Soviet scientific research satellites have provided them considerable data. However, the majority of Soviet near earth space systems have not been scientific research satellites. The majority of these systems have been satellites that provide both direct and indirect support to their military capability. Some of this military support can be found in their utilitarian or applications program—the "Johnny-come-lately" of the Soviet space program.

Utilitarian (Application) Satellites

Soviet utilitarian satellites developed slowly, apparently due to early higher priorities in other areas and perhaps even because data from many U.S. satellites was, to some extent, available for Russian use. In recent years, three utilitarian programs have emerged: communications, weather, and navigation.

Communications Satellites

The Russian communications satellite (ComSat) program, Molniya, has been their most active as well as their first utilitarian program. Although there probably were earlier research and development launches, the first operational vehicle was orbited in April 1965 from Tyura Tam by the SL-6 launch vehicle system. The orbit they use is quite different from those used by U.S. communications satellites. We use synchronous equatorial orbits while the Russians use a highly elliptical 12-hour orbit inclined between 64-65 degrees. The timing of this orbit results in the ComSats spending most of their time over the northern hemisphere. This provides the Russians considerable line-of-sight time between their primary ground stations at Vladivostok and Moscow. Three vehicles appropriately spaced will provide them 24-hour capability between those cities.

They have successfully orbited 10 Molniya vehicles but have had numerous reliability problems. The lifetime of these vehicles is presently assessed to be 13 months or less, and only 2 or 3 of the 10 vehicles orbited are still operating today.

The Molniya vehicles are quite large, weighing about 2000 pounds. They have a communications capability comparable to U.S. ComSats. This includes relaying black and white TV, radio, multichannel telephone, facsimile, and telegraphy. They have also been used in conducting color TV experiments in cooperation with France.

The Molniya ground network is called Orbita and is constantly being expanded. Some of the stations are located in remote areas of the USSR; thus they are using their ComSat program as an excellent means of tying in some of their more inaccessible areas. However, they are not able to offer two-way communications between more than two ground stations at once. Moreover, the Molniya orbit does not offer much potential for communications with areas outside of Eastern Europe. Because of this, we may in the near future see the Soviets develop a synchronous equatorial satellite to enhance their communications capability.

Meteorological Satellites

Meteorological or weather satellites (MetSats) have been household names in the United States since the early 1960's. It was not until June of 1966, however, that the Soviet Union announced they had a MetSat. They attempted at least four MetSat launches between 1964 and 1966, but the June 1966 launching of Cosmos 122 marked the first indication of an operational capability, albeit a developmental satellite.

The Russian MetSat program is carried under the Cosmos label and has not been very active. The early vehicles were launched from Tyura Tam on a 65 degree inclination. The program was moved to Plesetsk in 1967, and three vehicles were launched on an 81 degree inclination in 1967. This higher inclination provides greater worldwide coverage. Two more vehicles were launched in 1968 from Plesetsk, but only one of the five operational vehicles orbited since 1966 was operating at the end of 1968 and there are indications that it is about to fail.

The vehicle itself is quite large, weighing approximately 3000 pounds. It carries TV and a multiple infrared system. The primary power source is solar cells mounted on two large panels. The Russian's MetSats are not synchronized with the sun like U.S. MetSats. As a result, they use batteries as a backup power source when the vehicle is eclipsed from the sun. This may account for the heavy weight of the vehicle.

The United States and the Soviet Union have an agreement for the exchange of weather data. Although their cloud cover photographs have been comparable in quality to our own, the Russians have not met their obligations to relay the data to the U.S. within prescribed times and have not had the number of operating vehicles in orbit that we have had. We can safely say that the USSR has been getting the best of the weather satellite agreement.

Navigation Satellites

The last USSR utilitarian program to appear is their navigation satellite (NavSat) program, which the Russians have never announced as operational. They categorize their NavSats under the Cosmos scientific label, which may mean they still consider it a research and development activity. They began the program in May 1967, and the vehicles are placed on a nominal 74 degree inclination which gives them good global coverage. The altitude of the vehicles varies, but many of them average between 300 and 400 miles, which is outside the major forces of drag while still low enough to enable them to obtain good fixes in relatively short periods of time.

Although the NavSat program apparently had a low priority in the beginning, it may now have more emphasis as demonstrated by an increasing launch tempo. Three vehicles were orbited in 1967 and five vehicles in 1968. The reliability of the system appears better than that of their ComSats and MetSats. Five of the vehicles were still transmitting at the end of 1968.

One reason postulated for the late appearance of a Russian NavSat is that the Soviets had access to our own NavSats. In fact, there is some conjecture that even today they may be using their own NavSats simply to fill gaps. Current Soviet operational use of the NavSat appears limited to surface ships. Eventually, the data should be precise enough for use by their submarine fleet.

It should be evident that all the utilitarian programs developed by the Soviet Union have a military support capability. The same thing can be said about comparable programs developed in the United States. There is one significant difference, however. In the United States there can be a valid question raised as to the primary purpose of these vehicles. Most of the communications satellites have been developed or operated by a civilian space agency, NASA, or private enterprise. The MetSats have also been primarily the province of NASA despite obvious use and application to the military. In the Soviet Union, there is no such question. The Soviet space program is, has been, and probably will continue to be, a military directed program containing a pronounced military threat— despite their propaganda claims for research and peaceful use.

MILITARY THREAT PROGRAMS

If the Russian utilitarian satellites suffered from low priorities, it may have been because of the obviously high priority placed on the development of a satellite reconnaissance program. This program has been the most prolific, and the most successful, of all of the Russian unmanned space programs.

Reconnaissance

The initial effort by the USSR to orbit a reconnaissance satellite may have taken place in 1961, but their first successful reconnaissance satellite was launched in April 1962 from Tyura Tam by the SL-3 launch vehicle. This began an aggressive program which became operational in 1963 and has increased ever since. It is considered part of the Cosmos program.

Russian reconnaissance vehicles are normally launched on inclinations between 51 and 72 degrees from Tyura Tam and Plesetsk. During 1968, however, they varied this somewhat when they placed two vehicles in a near polar 81 degree orbit, apparently to obtain better coverage of the icecap region. The height of the vehicles varies during the orbit but averages between 110 NM at perigee and 180 NM at apogee. Most of the vehicles remain in orbit for eight days, which results in approximately 127 revolutions of reconnaissance activity. The lifetime of two reconnaissance vehicles was extended in 1968 to 12 days while one reconnaissance vehicle early in 1969 remained in orbit for 13 days. The extended lifetime of these vehicles would appear to be an attempt to develop a more cost-effective reconnaissance capability.

They employ two payloads in the program— both of which are apparent modifications of the basic Vostok-Voskhod manned space vehicle. One of these, a 10,000 pound vehicle, is known as the low resolution system. The low resolution system also has the capability to gather electronic intelligence (ELINT).

The low resolution system appears to have four cameras in the vehicle: a very low resolution framing or indexing camera to determine the desired area of coverage, an attitude or horizon camera for camera pointing, and two data gathering intelligence cameras. The intelligence cameras have a ground resolution of between 20-30 feet, providing a capability for search and detection as well as geodetic and mapping data.

The high resolution system is more complex. It apparently has five cameras: a framing or indexing camera, two horizon cameras (this vehicle has a roll capability of approximately 19 degrees), and two longer focal length intelligence cameras with a 5-8 foot ground resolution capability. This system would appear to be designed for technical intelligence collection.

In the operation of the photo reconnaissance mission, camera operations are controlled by in-board memory units. Initially, instructions are loaded after the vehicle has been injected into orbit. These instructions are updated each day the vehicle remains in orbit.

The ELINT system on the low resolution vehicles records data, stores and transmits same to ground receiver stations on command. The ELINT system is an entirely separate system from the photo system, and during a typical eight-day mission the satellite can produce 11 hours of ELINT data on such things as radar scan rates and radar lobe widths.

During 1968, the Russians successfully orbited 29 reconnaissance vehicles. Fifteen of the vehicles were low resolution and 14 were high resolution vehicles. Although there were no major changes in the operational systems during 1968, the Russians did conduct some tests of nonrecoverable ELINT collectors and demonstrated a maneuvering capability in some reconnaissance vehicles— possibly the forerunner of a new generation of reconnaissance vehicles. Through mid-March 1969, they have successfully orbited five more reconnaissance vehicles.

The Russian reconnaissance program has been an active one, apparently fulfilling a relatively well-defined role of strategic reconnaissance. The next military threat system to be discussed is not as well defined.

Space Weapons

During the Moscow parade of 1965, the Soviet Union displayed a 115-foot missile, the Scrag, which they claimed was capable of striking the United States on the first or any successive orbit. This was not the first time the Russians claimed a space weapon capability. The Soviet Union in the past has made many claims that it possessed "orbital rockets." In the past few people gave credence to these Soviet claims, but with the Scrag, the Russian interest in space weapons was clearly evident. Moreover, the technological capability to develop and deploy a space weapon system is clearly within the Russians' grasp.

A space weapon system can be deployed in various modes. It might be used as a Fractional Orbit Bombardment System (FOBS), in which the vehicle is placed into orbit, but before it completes one revolution of the earth, a warhead is reentered on a pretargeted facility.

A more complex mode is the Multiple Orbit Bombardment System (MOBS). A MOBS would be placed in orbit for varied periods of time; then eventually the warhead would be reentered on a pretargeted or even retargeted facility.

There are many variations to the MOBS concept. Some look at low orbiting vehicles which would reenter after a short period of time— a few revolutions or a few days. Other concepts envision vehicles in long duration orbits or eccentric orbits in which warheads are for all practical purposes stored in space. Then, when necessary or desired, these vehicles would be placed into low orbits for final reentry of the payload on a target.

Although not truly a space weapon, one other system is often considered in a discussion of space weapons: the Depressed Trajectory ICBM (DICBM). The DICBM does not achieve orbit. It is a ballistic missile placed on a trajectory that has a low apogee resulting in a depressing of the entire trajectory. This depressed trajectory results in shortened radar detection ranges, shorter flight times, and some trajectories which can exploit holes in existing detection systems.

During the past two years, there has been much publicity on Soviet development of a FOBS. In 1967, Secretary of Defense McNamara announced the probable development of a FOBS system by the USSR. During the same year, some DOD agencies credited the Russians with a rudimentary orbital bombardment system that posed a threat to the United States. More recently, however, the tenor of statements on the FOBS has been less positive. Secretary of Defense Clifford in his defense posture statement noted that a degree of uncertainty existed in our earlier estimates and that "It is possible that the Soviets are trying to develop a weapon which could perform as a depressed trajectory ICBM, a FOBS, or a dual system."[3]

The primary area of contention appears to be deployment. The tests the Russians conducted clearly have application to FOBS or DICBM, and the two systems are closely related. Both offer a new dimension to Soviet strategic capability (with inherent advantages and disadvantages), and both may provide a technological data base which could eventually lead to development of advanced orbital weapon systems. Our present space and missile defense capability is inadequate to cope with either system.

The tests of FOBS/DICBM began in December 1965 with a suborbital launch from Tyura Tam. The vehicle was placed on a depressed trajectory (120 NM apogee) with slightly over 11 minutes of coast before third stage ignition. The vehicle exploded after third stage ignition. Two more suborbital tests were run in February and May of 1966. The February test may have been successful, and the May test apparently was a success.

After the three suborbital tests, the Russians began orbital tests. The first test was in September 1966, but they did not appear to achieve success until their third try in January 1967. This vehicle (Cosmos 139) was launched from Tyura Tam to the south with a 49.7 degree inclination. This brought the vehicle back for reentry in the Kapustin Yar recovery area. The vehicle was in a very low orbit with an apogee of 112 miles and a perigee of 72 miles and was reentered before it completed one revolution— meeting the expected criteria of a FOBS. Since that test they have launched 12 more tests of the system, all on a similar profile. Each of the vehicles was carried under the Cosmos label, and during the period from 17 May 1967 to 18 October 1967 there were seven consecutive successes in the program. It was this string of successes that led to the assessment of a rudimentary orbital bombardment capability.

The system tested in this series has been designated the SS-X-6. The launch vehicle system is the SL-11 discussed earlier. The capabilities of this system in a FOBS role have been assessed as being able to place approximately 7200 pounds in low earth orbit and to reenter a 2200 to 3100-pound payload with a circular error probable of between one and three nautical miles at ranges up to about 16,000 nautical miles. This is not as accurate, nor is the payload weight as great, as that which could be delivered by ICBM's or manned bombers. However, the depressed trajectory nature of a FOBS decreases detection ranges while the orbital mode provides a potential for a wide variety of delivery routes and essentially an unlimited delivery range if they modify the tested system.

The system as tested does not appear capable of striking the U.S. as a FOBS. However, if the Russians decrease the payload weight or increase the boost capability of the launch vehicle system, or use a more powerful booster, they could deploy a FOBS which would be capable of striking the U.S. on the first revolution.

The low accuracy of such a system would not permit use against hard targets, but it could be used on soft targets. The decreased warning time inherent in this system would make it attractive for use against soft time-sensitive targets. Moreover, the possibility that the system could be hidden in hardened SS-9 silos can complicate our threat assessment problem.

During 1968, the Russians again used the SS-X-6 in a DICBM role. The vehicles were launched from Tyura Tam and impacted in the Pacific. Apogee height of these tests was 300 miles, less than the normal apogee height for this system in an ICBM role. These tests continue to cloud the issue on Soviet intent. Clearly, though, the interest and technological capability exist to use space for an offensive weapon system. If the Russians believe the element of surprise which might be available from space weapons will significantly complement their strategic offensive capability, neither high costs nor the space treaty will be likely to deter its use.

FOBS may not be the only space weapon system being developed by the Soviet Union. During 1968, some nonrecoverable, maneuverable satellites were launched by the same launch vehicle system used for FOBS (SL-11). In one test, two vehicles were launched a day apart with the second vehicle being placed into a coplaner orbit. Later, the second vehicle was observed to be spinning, and fragments were separated from the vehicle. A third vehicle was launched about two weeks later, and after a coplaner rendezvous, both vehicles broke up. There is no firm mission assessment of this program, and although it could be tests of space rescue or resupply vehicles, the flyby rendezvous technique demonstrated in these tests has definite application to a satellite inspection and negation system— long considered a Soviet desire.

DEEP SPACE PROGRAMS

Lunar Program

The major goal of the United States space program is to place a man on the moon and return him safely to earth by 1970. This goal was established by President John F. Kennedy in 1961. Implicit in this goal is a requirement to explore the moon with unmanned space vehicles. Almost two years before President Kennedy articulated this goal, and more than four years before the first successful U.S. lunar satellite, the Soviet Union began an onslaught on the moon with an aggressive if not entirely successful program. The Russian lunar program is a high priority effort that has recorded every space first associated with unmanned lunar vehicles.

The Russians attempted their first lunar launch in December 1958 but failed due to launch vehicle problems. The next month, however, Russia became the first nation to send a vehicle to the moon when Lunik 1 flew past the moon and became the first vehicle to go into a heliocentric (sun centered) orbit. The vehicle was designed to impact the moon, but, nevertheless, the Russians claimed this vehicle as a space first. They followed with Lunik 2 in September 1959, and this vehicle, apparently identical to Lunik 1, did become the first vehicle to hard land on the lunar surface.

Of their early lunar successes, the most spectacular was Lunik 3 in October 1959. In photographing the backside of the moon, Lunik 3 accomplished something that the United States was unable to do until 1966.

Luniks 1, 2, and 3 comprised the first phase of the Russian lunar program. These vehicles were all launched from Tyura Tam by the SL-3 launch vehicle, and all three vehicles used a direct ascent to the moon. These successes garnered excellent propaganda value for the Russians while providing them useful data on cislunar space. Relatively unnoticed, and unpublicized, were at least three failures during this phase of the program.

The Russians launched Luna 4 in 1963, to begin the second phase of their lunar exploratory program. It was boosted by the SL-6 launch vehicle into an earth parking orbit and then ejected from the parking orbit into a lunar transfer trajectory. This is the same basic procedure used by the United States. Luna 4 was followed by Luna 5, 6, 7, and 8, all launched in 1965, each of which appeared to be attempts to softland a vehicle on the moon, although Luna 5 may have been an attempt to place a vehicle in lunar orbit. None of these vehicles accomplished their primary mission. They did pave the way, however, for a space first when Luna 9 softlanded on the moon in February 1966. Luna 9 operated on the lunar surface for about three days and transmitted the first pictures of the moon taken from the lunar surface. The Soviets quickly followed with another space first in April 1966 when Luna 10 became the first vehicle to orbit the moon.

The year 1966 was significant in the Russian lunar program. They followed Luna 10 with two more lunar orbiting vehicles: Luna 11 and 12 in August and October respectively. They finished the year with another soft landing—Luna 13 in December—a vehicle which according to the Russians was the first vehicle to probe the lunar surface.

During 1967, the Russians did not attempt any lunar probes, but 1968 was another big year for them in this effort. They successfully placed Luna 14 into a lunar orbit and then began what can be called the third phase of their lunar program, circumlunar flight.

This phase used the SL-12 launch vehicle and began with a circumlunar attempt in February 1968. It was unsuccessful due to a failure in the upper stage of the SL-12. A similar failure took place in April.

In March, they launched Zond 4 on a simulated circumlunar flight. The vehicle was placed on a reciprocal translunar trajectory, so had the moon been 180 degrees from its position, it might have been a successful flight. The real spectaculars, however, were Zond 5 and 6 in September and November.

Zond 5 recorded another first for the Russians when it became the first vehicle to complete a circumlunar mission. After completing the circumlunar flight, Zond 5 reentered the earth's atmosphere on a ballistic trajectory and was recovered from the Indian Ocean. This marked the first successful water recovery for the Russians. Some agencies believe that this was not the primary recovery mode—that in reality the Russians intended to have the vehicle "skip" out of the atmosphere for a recovery on the Soviet land mass. This might be true, but, nevertheless, they did successfully recover the vehicle from the Indian Ocean, which indicates they were well prepared even if this was the secondary reentry mode.

If the Zond 5 flight was not all the Soviets wished it to be, Zond 6 in November was. Zond 6 completed an unmanned circumlunar flight and this time, using lift, did reenter with a "skip" through the atmosphere to a successful recovery in the Soviet Union.

In the future, we can assume that the Russians will continue the lunar program at a relatively high level of intensity— eventually culminating in a manned lunar landing. It is not likely that they will beat the United States in the race to put men on the moon so we should look for them to attempt some spectacular feat which will soften the prestige impact of a successful U.S. manned lunar landing. One possibility that has been mentioned is an unmanned probe which will land, collect material, and then return to earth. They may have this capability, and this mission would provide considerable propaganda value. A claim that would be heard is that their unmanned vehicles can perform comparable tasks to our manned vehicles.

Interplanetary Program

One area remains to be considered in this review of the USSR unmanned space program— interplanetary activities. The Russian interplanetary program has not been really successful, but they have launched about three times as many vehicles as the U.S., and the vehicles they have launched have been about three times the size of our space vehicles. They have attempted at least 22 interplanetary flights with only two flights resulting in a high degree of success. They have, however, claimed at least partial success on six other vehicles, and two of the vehicles are en route to Venus.

The Russian interplanetary program began in October 1960 with a Mars attempt that was unsuccessful, due to an upper stage launch vehicle failure. This was also the primary cause of failure on most of their early interplanetary flights. This first attempt, like all since, was launched from Tyura Tam by the SL-6 launch vehicle system.

Their first partial success was Venus 1 in February 1961. They called Venus 1 a success because it was the first vehicle to be placed on a trajectory to another planet. In reality it was unsuccessful because communications failed 15 days after the vehicle entered a trans-Venus trajectory. The communications problem encountered with Venus 1 has been the primary cause of failure in those vehicles that did achieve an interplanetary trajectory.

A Mars vehicle launched in November 1962 had a communications failure in March 1963. Zond 1 placed on a Venus trajectory in April 1964 failed after approximately 46 days. Zond 2 failed en route to Mars shortly after three months from launch.

In an attempt to solve the communications problem, the Russians launched Zond 3 in July 1965. Zond 3 was a photographic and communications test bed, and it worked quite well. It photographed the backside of the moon and then entered a heliocentric orbit. The communication system functioned for at least eight months and at a distance of about 81 million miles.

After this success the Russians attempted three Venus probes in 1965. One vehicle, designated with the coverup Cosmos 96, did not get out of earth parking orbit. Venus 2 and 3 did achieve a trans-Venus trajectory. Venus 2 flew by the planet, and Venus 3 accomplished a first when it impacted on the Venusian surface. However, just as in earlier flights, communications problems resulted in an unsuccessful mission. Communications failed just before fly-by and just before impact so no useful data were acquired from these vehicles.

The Russians did not attempt another planetary probe until 1967, no doubt working to improve their communications system. In 1967, they attempted two Venus probes. One of the vehicles did not get out of its parking orbit; however, the second vehicle, Venus 4, accomplished a significant first.

Venus 4 softlanded an 845-pound payload on the Venusian surface in October after a normal 128-day flight. The payload was detached from a 2400-pound carrier, which burned on entering the Venusian atmosphere. According to Tass, the carrier entered the Venusian atmosphere at 215 to 270 miles from the planet, and the entry vehicle was ejected. Initially, atmospheric braking reduced the vehicle's speed but increased the outside temperature. They protected the entry vehicle with ablating material. A heat-resistant parachute was deployed between 13.5 and 10.8 miles from the surface, and it slowed the vehicle's descent to about 33 feet per second. The final impact on the surface occurred at 10 feet per second.

There have been some questions raised as to the validity of the scientific data obtained by Venus 4, and there were apparently some problems with the vehicle. The altimeter system may have malfunctioned, resulting in erroneous correlation of data and altitude. The vehicle itself may have been crushed before reaching the surface, due to a miscalculation of the density of the Venusian atmosphere. Therefore, despite the soft landing, the vehicle was probably not intact, which would account for the relatively sparse amount of substantive data released by Russia on the findings of Venus 4. This flight did show that the Soviets have overcome their communications problems and demonstrated great accuracy in their space tracking systems as well as command and control systems.

They presently have two more vehicles, Venus 5 and 6, on a trajectory to Venus. In a departure from their normal mode of operation, the Russians quickly announced that these vehicles were to be soft-landed— apparently like Venus 4. This early announcement shows great self-confidence in their ability to accomplish this complex task again.

CONCLUSION

The Russian space program has grown considerably in every measurable aspect during the 11-1/2 years since Sputnik 1. This past year, they exceeded the United States in both the number of launches and number of vehicles successfully orbited. This is the first year since 1957 that this has occurred. In recent years, about 50 percent of their launch attempts have been in direct support of military operations while others can provide indirect support to military operations.

The question often arises, "Does the Soviet space program really present a military threat?" This question sometimes evokes as much emotionalism as the deployment of an antiballistic missile system in the United States, and the opinion is almost as diverse. This much we do know: the military role in space is consistently recognized in Russia, and in their organization for space exploration the military is the dominant agency.

Although it is difficult to determine the exact Soviet expenditures on their vast space activities, most estimates place the costs at a higher level than U.S. expenditures and in terms of a percentage of gross national product, far in excess of the U.S. program. In assessing a nation's space program, it must be viewed within the priorities that have been established for all of that nation's activity. This is true of the U.S. space program as well as that of the Soviet Union. However, when the space program of the USSR is studied, it must also be viewed from one additional standpoint within the context of overall Communist policy — that of world domination. Within that context, the USSR space program can be viewed only as a military threat.

NOTES

1. U.S. Congress, House of Representatives, Report of the Committee on Science and Astronautics, (90th Cong., 1st sess.), Washington: GPO 1967, p. 3-5.

2. Anatoly A. Blagonravov, "The Soviet Union's Activities in Space During the Past Decade," Astronautics and Aeronautics, Vol. V, No. 10 (October 1967), p. 70.

3. Clark M. Clifford, "The 1970 Defense Budget and Defense Program for Fiscal Years 1970-74," Washington: Department of Defense, 1969, p. 43.

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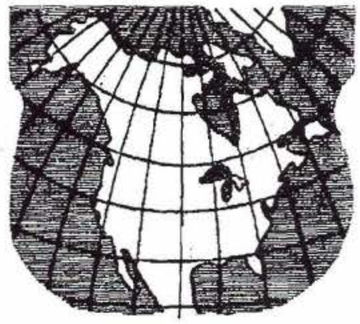

THOUGHTS ON AEROSPACE DEFENSE, 1970-1985

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The Soviet Union continues to pose a serious threat to the security of the United States and has recently developed several new offensive weapon systems. Some of these systems operate in space or can strike from space. These Soviet systems are now operational but there are no operational systems in the U. S. which can defend against them.

During recent years there has been a steady erosion of American strategic defense forces. This erosion has now reached a point that very serious consideration is imperative in order to determine whether these forces have not already dwindled to the point where they are no longer capable of providing the protection the people of the United States have come to expect from the Air Force. This paper analyzes the threat and suggests some options open to defense planners during the next fifteen years.

The United States has not accepted the "ultimate weapon" concept and, consequently, must face a continuing obligation to maintain an aerospace defense, tailored to the threat, and with a vital role in our "deter, defend, retaliate, survive, and terminate" sequential strategy for general war. Specific responsibility for early warning and the protection of the retaliatory forces are the deterrent functions of aerospace defense forces.

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For the past decade, however, nuclear weapons, high-speed delivery systems, and exotic penetration aids have made the "defend" and "survive" portions of air defense doctrine little more than a series of academic considerations. Defense planners have been confronted with such alternatives as: (1) go for 100 percent effective aerospace defense capability, probably unattainable, at a cost which would undoubtedly reduce all other military forces to a minimum and possibly necessitate a return to a foreign policy of isolationism; (2) go for something less than a 100 percent effective air defense system, which is, at the least, undesirable and which must be supplemented by hardening or dispersal of retaliatory forces and a high-cost civil defense program for survival; (3) abandon efforts to develop air defense destruct capability, which, at best, would be unsatisfactory, and concentrate on a guaranteed or foolproof early-warning system to further improve the reaction capability of retaliatory forces. Essentially, defense has not been permitted to maintain pace with the threat. The range of options available in continental defense, coupled with the restrictions of budgetary limitations, leaves little choice for the U.S. other than a policy of "deterrence and prayer."

To be effective, aerospace defense must maintain a balanced capability to neutralize all delivery systems — yesterday's, today's, and tomorrow's. With nuclear weapons, the subsonic manned bomber, unopposed, can inflict as much unacceptable damage as the ICBM or an offensive space system. High-cost systems, plus the menace of weapons scaled to 100 megatons (MT), have made it mandatory that aerospace defense — defense in the classical sense, not defense by deterrence — be tailored to the threat if it is to be anything more than a token gesture. This requires accurate and timely intelligence on the enemy air order of battle, operational tactics, and the intent of a potential enemy. It also requires technological intelligence with special emphasis on research and development trends to insure effective management of our own R&D programs so as to minimize the possibility of technological surprise.

For the period 1970-1985, our defense must consider a possible threat comprising:

* <u>Subsonic Manned Bombers Employing Electronic and Conventional Penetration Aids</u> — Will phase out not later than 1972.

* <u>Manned Bombers with Supersonic Capability Employing Air-to-Surface Missiles and Penetration Aids</u> — Should become operational prior to 1975 and remain a threat throughout the period.

* Ballistic Missiles— Should remain effective through 1980 with hardened land-based launch sites and underwater launch from submarines.

* Space Offense Satellites (Unmanned)— Fractional orbit and/ or a multiorbit capability, positive command reentry system or near-space detonation options— possible threat as early as 1972 and extending through the end of period.

* Manned Multipurpose Aerospace Craft—Maneuverable weapon-launch capability from space or atmosphere; reconnaissance and self-defense capability, employing penetration aids and both active and passive countermeasures— possibility from 1972 to end of period.

The aerospace defense force, in-being or programmed, to counter this threat is composed of: (1) manned interceptors, supplemented with guided air-to-air missiles, considered adequate against manned subsonic bombers; (2) an improved manned interceptor, coupled with over-the-horizon radar, to counter supersonic air-to-surface missile-equipped manned bombers— neither of these systems is yet operational, although both are in the advanced test phase and look extremely promising; (3) Sentinel, still in development phase, our only current anti-ICBM program; (4) antisatellite system, with a very limited operational capability, capable of satellite inspection and destruct from three to eight orbits after launch.

An objective analysis of the estimated threat versus the programmed air defense force reveals the continued inability of defense to cope with the threat. However, the U.S. emphasis on space exploration may well serve as the catalyst for the revitalization of the aerospace defense function and a return to its former strategic importance.

Many technical questions must be answered before man can predict the effect of space developments on his future. The next decade should see most of them answered and some concrete evidence of the impact of space on our civilization. Certainly, never before in history have two nations expended such vast resources, with such a sense of urgency, in such a short span of time to find the answers. Both nations proclaim that their efforts are devoted wholly to "peaceful" exploitation of space for the benefit of all mankind and disavow any military ambitions in the medium. However, one cannot ignore the fact that these two powers have been locked in an open, jointly acknowledged "cold war" for the past twenty years to preserve and expand their political systems—a race characterized by: (1) the disbursement of billions of dollars of economic and military assistance to their respective allies and the uncommitted nations; (2) overt and covert political and military actions running the gamut from "brinkmanship" to "missile confrontations," from "police actions" to "counterinsurgency operations," at a cost of billions of dollars and several thousand lives; (3) no appreciable reduction of intensity during several changes of government leadership in both nations; and (4) little or no willingness to consolidate, pool, or share resources for a joint space venture.

In view of the factors cited above and of our avowed national policy—"space for peaceful purposes" — the United States must, of necessity, assume the basic responsibility for protecting and preserving this environment for peaceful purposes. To accomplish this, we have the alternative either of extending our offensive capability into space in a deterrent role or of developing a strong defense capable of satellite inspection and negation prior to overflight of the North American continent. The defensive approach appears to be the most palatable one politically. It is the approach which probably would provide a credible, effective capability in the most rapid manner.

Aerospace defense must have two basic capabilities, warning and negation. Effective warning requires surveillance, detection, and tracking, while negation involves the selection and launch of an interceptor vehicle as well as interception, inspection, and the capture, neutralization, or destruction of a target. Communication is a mandatory prerequisite to either function.

Technological forecasts for the 1970-1985 time period predict capabilities in these areas which would not only provide adequate space defense but would also enhance the effectiveness of our current and programmed air defense systems. The following technological concepts are considered to be technically feasible during this period, compatible with several possible national strategic space concepts, and sufficiently flexible to adapt to whatever degree of national strategy is implemented:

Space-Based Alarm System— This is a hybrid but integrated system of unmanned satellites providing:

1. Real-time intelligence on the enemy's readiness posture, including the alert status, and launch of all offensive systems to include aircraft, missiles, satellites, and spacecraft.

2. Real-time intelligence on the location and movement of all surface vessels and submarines.

3. Launch detection, preliminary trajectory and tracking data, and estimated impact point within ten nautical miles.

4. Continuous communication with instantaneous readout on demand.

All data would be processed through a national command and control center. While this system is designed to meet aerospace defense requirements, the major portion of its intelligence "take" in the constant surveillance phase will be of inestimable value to many DOD and other government agencies.

This system could consist of three interrelated and overlapping subsystems. The first of these would be composed of five unmanned satellites positioned in synchronous equatorial orbits, each satellite with an assigned target area providing continuous ground surveillance. This subsystem would have a simultaneous capability against all predicted threats; against south launches. It would provide launch-point data, raid-size assessments, and impact-point predictions. The second subsystem would consist of eight unmanned satellites positioned in four equally spaced polar-orbital planes at an altitude of 240 nautical miles. The two satellites in each plane are separated by 180 degrees. All eight satellites are progressively staggered 45 degrees apart in latitude in a westerly direction. This subsystem would provide continuous ocean surveillance against all surface and subsurface vessels, plus oceanographic data, antisubmarine warfare (ASW) buoy barrier readout, and electronic intelligence (ELINT) and communications intelligence (COMINT) ferret data. It would also provide the location of every vessel at sea or in port within 24 hours after going into operation. The third subsystem consists of three unmanned satellites in near-earth orbit of 200-500 nautical miles, depending on target area. They would have a maneuver capability with a relatively short life span of up to 18 months for use against specific target areas. This continuous surveillance subsystem, employing optical-electro-infrared (IR) sensory equipment, would provide highly refined, definitive surface intelligence with instantaneous readout on demand. This system could be positioned for use against virtually any land mass on the globe.

<u>Space Capture, Inspect, or Destruct System</u>— This system, completely integrated with alarm devices, would utilize refined after-boost

or terminal-tracking method. It would consist of two unmanned satellites in synchronous orbit covering all approaches to the North American continent and providing a triangulation capability for precise target tracking. The second subsystem would consist of a land-based mix of manned and unmanned space interceptors. These would be utilized on an instantaneous launch capability to capture, inspect, and/or negate unidentified vehicles. A proposed refinement, not considered feasible until late in the period, would place six aerospace defense stations in a near-earth orbit between 350 and 700 nautical miles. Each station would be equipped with several unmanned interceptor missiles and would possess an automatic target lock-on and launch capability when assigned a target for destruct.

These technological concepts provide many options and considerable flexibility regardless of the strategic concept which may be adopted. Among strategic concepts which the United States could consider for space are the following:

1. A program dedicated solely to the exploration of space. This would require a unilateral disavowal of any primary or auxiliary military capability in space. Present surveillance, communication, weather, and/or other satellites with military potential would be turned over to the custody of the United Nations and the data made available to all nations.

2. The U.S. would concentrate on space exploration only but would develop a space alarm system for the United Nations which would provide surveillance of all the earth, including the United States. It would also provide tracking and detection capability to be utilized by a UN space control agency and would include an intercept capability to be utilized by a UN space force for inspection or rescue.

3. A U.S. space system devoted to a warning capability only. This would involve a vast civil defense program, which would pick up any slack in the national economy caused by the associated defense cutbacks. It would have the added advantage of a more widespread and equitable distribution of the federal funds committed.

4. Space control, a concept involving joint U.S. and Soviet operations in space or, in fact, multinational operations in space but with the United States maintaining a military space defense system capable of protecting North America from offensive weapons after launch.

No U.S. offensive capability.

5. Limited space denial, a concept under which the U.S. would maintain an aerospace defense capable of destroying offensive weapons during or immediately after launch. No U.S. offensive capability.

6. Space denial, a concept under which U.S. would destroy all satellites, regardless of mission, of a potential enemy. No U.S. offensive capability.

7. Space permissive denial, a concept in which the U.S. would maintain aerospace forces with surveillance and destruct capability and which would permit selective satellite interception and destruction. U.S. offensive capability in space would be required.

8. Space denial with dominance, a concept under which the U.S. would deny use of space to a potential enemy while exploiting all aspects itself. This concept would require the U.S. to assume offensive capability in space.

There are many more possible options, but they would be combinations or parts of those already listed. Presently, the United States appears to be concentrating on the first three options. These options do not provide true defense in the classical sense, nor do they provide for deterrent or retaliatory functions. Survival with this philosophy was possible in an environment where all weapons were limited to the earth's atmosphere. Survival with this philosophy of strategy in an environment of ultra-high-speed space delivery systems is not possible.

There is urgent need for revision of U.S. strategic defense strategy. This strategy must provide options which will not only blunt Communist efforts but also take the initiative from the Communist powers in their attempt to manipulate world affairs. More important is the need for a convincingly fearless expression of United States resolve to implement its denial options of space strategy.

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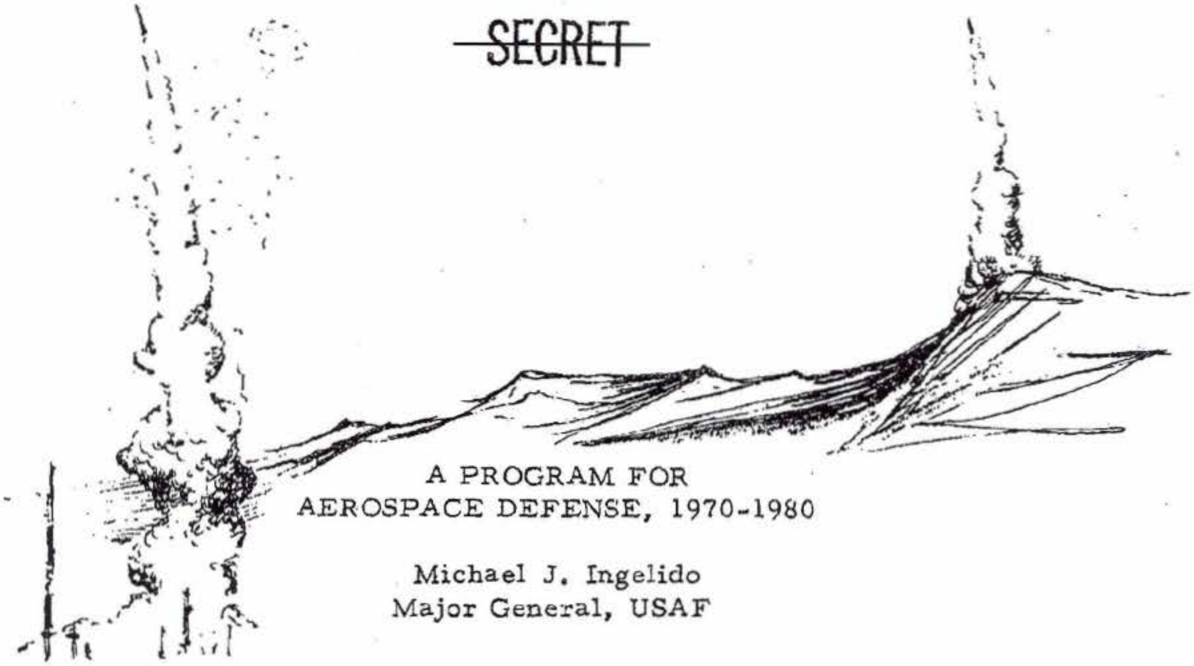

A PROGRAM FOR AEROSPACE DEFENSE, 1970-1980

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The policy of the United States is to maintain a sufficient mix of effective strategic forces to deter the present and projected threat of the Soviet Union. Although either the U.S. or the USSR could initiate an attack, neither at this time could successfully destroy the other's retaliatory capability. In response to an all-out Soviet attack, the United States has the residual capability to deliver a retaliatory strike which would produce sufficient fatalities and destruction of key industries to eliminate the USSR as a viable nation.

For the foreseeable future, the current U.S. policy of deterrence and response will apply equally to the emerging nuclear threat of the Chinese Peoples Republic (CPR).

MISSILE AND SPACE THREAT - 1970-80

Evidence indicates the USSR is developing, testing, and deploying a broad mix of strategic missile and space nuclear weapon systems. Moreover, the rapid growth of these capabilities, beyond our national intelligence estimates of recent years, indicates that the Soviet Union is dedicated to the attainment of strategic weapons superiority over the United States. Current national estimates indicate the Soviets are deploying nuclear powered submarines capable of launching ballistic missiles in a surprise attack against targets deep in the U.S. mainland.

The USSR has been experimenting with and have tested a Fractional Orbit Bombardment System (FOBS). In light of the current

U.S./USSR peaceful use of space agreement, the FOBS concept neatly skirts the technicalities of the treaty by being a ground-based rather than an orbital-based nuclear bombardment system. Notwithstanding this loophole, current U.S. estimates credit the Soviets with the capabilities to employ the FOBS in a crisis. Soviet secrecy and budgetary camouflage precludes any factual assessment of the full range of USSR space activity and its potential application; however, it is estimated that approximately 30 percent of the current Soviet 60 billion dollar defense budget is allocated for space development.

Although the Soviet space reconnaissance and surveillance program was initiated in 1962, nearly two years after similar U.S. activities, they have since launched approximately 133 satellites which have provided nearly continuous global coverage and data collection. Their space program has also demonstrated capabilities in weather reconnaissance, communication and navigation systems. Along the way the USSR established an international space record in April 1968, with nine launches in a 12-day period. On 14-15 April 1968, a capability for unmanned, noncooperative satellite rendezvous was demonstrated with Cosmos 212 and 213. In January 1969, the launch, rendezvous, and personnel transfer between Soyuz 4 and 5 demonstrated even more advanced manned space capabilities. Possible military applications could run the gamut from space-based command and control, personnel replacements, logistics support, satellite refurbishment, and rescue and recovery, to satellite boarding and inspection. Such capabilities lend startling credence to USSR political and military leaders' claims of "scientific" achievements.

To further complicate the missile and space threat to the United States, the Chinese Peoples Republic also has tested nuclear weapons and rudimentary delivery systems. It will probably develop some sort of advanced ballistic missile delivery system in the mid-1970's.

There is a strong probability that the Chinese Communists, with a delivery system for their nuclear weapons, will not be satisfied with a secondary position and role in the Communist Bloc. Their motivation to become a major nuclear power may prompt them to initiate development actions to acquire more advanced and sophisticated capabilities than are currently estimated.

CURRENT U.S. DEFENSE SYSTEM

50X8, E.O.13526

Existing U.S. capabilities in missile and space defense are limited to surveillance, warning and detection and identification of imminent attacks on the United States from the Sino-Soviet landmass. This limited capability is currently sufficient to provide warning to the National Command Authority (NCA), to alert time sensitive forces and command and control activities as well as government and civil defense agencies. On the basis of operational requirements specified in 1957, [redacted] — and remains — the minimum warning time acceptable for initiating U.S. responses. Currently deployed surveillance and warning systems provide insufficient coverage and, therefore, inadequate detection capability and warning time against the projected individual or combined USSR/CPR threat of the 1970-80 time period. Each of the American systems is vulnerable to electronic countermeasures and can be negated by sabotage or deliberate attack. Radar is subject to blackout from nuclear bursts in their field of view. Systems which employ forward or backscatter through ionospheric reflection are vulnerable to high altitude weapon bursts which disrupt the scatter medium. [redacted]

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The ground-based detection and warning system currently being deployed in the United States can be overflown by the USSR long-range sea-launched ballistic missiles (SLBM) postulated to be deployed in the 1970-75 period. The CPR missile delivery system would probably not appear until the early 1970's. At that time, determination of the country of origin of the missile attack would become a critical discrimination problem for the U.S.

In response to the CPR threat the U.S. has selected the SENTINEL System to defend our key population centers against ballistic missiles. While this action has been taken to reinforce U.S. policies and provide a bargaining tool in any disarmament talks with the Soviets, it must be remembered that SENTINEL is directed against CPR capabilities. The Soviet ICBM force is still the primary threat to the nation, and there are significant weaknesses in the survivability of elements of U.S. strategic offense and defense forces from surprise attacks. These weaknesses could be greatly magnified, if the Soviet Union were to elect to deploy high yield nuclear weapons in a space-based multiple orbit bombardment system (MOBS).

U.S. DEFENSE CAPABILITIES

Exercises conducted by the JCS have emphasized the importance of definitive information in decision-making and response in the event of a nuclear exchange. The variety of weapons available to the USSR, and the range of doctrines and tactics suited to their use, necessitate an assessment of the weight, motive, and probable success of the attack, as a prerequisite to initiating a U.S. response. Commanders of unified and specified forces charged with executing decisions of the National Command Authority must have similar information to initiate the proper response of their forces to obtain the maximum destruction.

OSD has stated a need for a U.S. capability to implement controlled and deliberate responses in a nuclear exchange. The lack of a range of doctrines and tactics to cope with a myriad of enemy actions ranging from coercive to assured destruction has been cited as a major weakness in our retaliatory capability. Nuclear wars with limited objectives are not outside the realm of possibility and would not necessarily warrant a U.S. "assured destruction" response.

As a result of the proliferation of nuclear weapons and their missile and space delivery systems, the United States could be confronted in the 1970-80's with strategic situations wherein conflicts could occur with or without initial U.S. involvement. In each situation, based on the assessment of the specifics of the exchange, there must be an appropriate U.S. response. The implications of overresponse to a contained conflict make even more critical the inadequacies in our current surveillance and warning systems to provide attack assessment information. Future U.S. surveillance and warning systems must be structured to cover the spectrum of attack possibilities that exist in a multiple aggressor environment.

FUTURE SURVEILLANCE SYSTEM REQUIREMENTS

A United States capability to implement controlled responses to a nuclear attack requires that the NCA be able to assess an enemy attack, the apparent motive, and available forces in order to initiate a response. There must be a credible and survivable surveillance system that can provide the NCA and key commanders with situational information for timely decision-making and for dynamic control of assigned offensive and defensive forces. It should have near-global coverage and be designed to provide continuing vigilance against enemy missile and space threat. It should provide near real-time tactical warning of imminent attacks on the United States, on our forces overseas, and on our Allies. Rather than simply providing an alarm signal, the surveillance system should also help to identify the aggressor and provide information describing his actions. Tactical information provided should include accurate reporting of the launch locations, type and number of weapons committed, apparent targets threatened, and predicted time of impact. Because they currently lack the means to obtain the necessary in-depth information, American decision-makers are obliged to operate with arbitrary rules for employment of the friendly offense and defense forces.

Unified and specified commanders likewise need definitive, near real-time surveillance information to effectively employ and control their forces in a rapidly changing situation. The defensive force commander requires accurate trajectory or orbit information on individual threat objects so that he may effectively employ his forces in the presence of countermeasures and sophisticated attack methods. Specific target information of a heavy attack would permit execution of preferential defense tactics. Timely and accurate surveillance information would identify an offensive suppression attack and avoid premature interceptor exhaustion. In the event of blackout or loss of interceptor radar system, the surveillance information could be used directly by the defensive system commander to vector interceptors. Accurate nuclear burst detection would aid in determining the defense's success as well as the success of the enemy action.

The retaliatory force commander should be able to use the surveillance system information to evaluate his strike effectiveness and to determine the success of the aggressors' damage-limiting activity. With the system's information, the strike commander can retarget or withhold his forces. With knowledge of which of his launched missiles have failed, have been intercepted or missed their targets, as well as which of his installations are about to be destroyed, and when, he can redirect his forces as appropriate. The ability to deviate from the preplanned response could be crucial to a successful outcome.

A surveillance system which meets the requirements for both the offense and the defense commanders would also provide for coordinated actions between commanders when timely tactics are critical to both the success of the attack and survival of the country. Finally, continuing factual information provided by the surveillance system on aggressor/friendly force residuals, and damage received or inflicted, aids in determining when to terminate the engagement.

A SURVEILLANCE SYSTEM CONCEPT

A promising surveillance system concept which capitalizes on U.S. space technology and provides the capabilities previously mentioned has been described in recent Air Force studies. Some segments of the concept are based upon evolutionary improvements to systems currently being developed in OSD-approved programs. The essential elements of this system are satellite sensors deployed in high and low altitude orbits; a communications and control satellite network; as well as survivable ground-based and airborne communications relay and computational facilities. This proposed surveillance system is sufficiently varied to provide tactical warning and, through the post-attack period, the situational information needed by the NCA for decision-making and by the unified and specified commanders for coordination and tactical control of the actions of their forces.

The proposed surveillance system consists of three parts:

* High Altitude Surveillance Platforms.

The high altitude surveillance platform (HASP) deployed in this conceptual system could employ infrared (IR) technology to provide launch and boost-phase observations of a missile and space attack. In the eastern hemisphere, satellites would be oriented to cover the entire Sino-Soviet launch area from which missile and space attacks could be expected. Similar coverage in the western hemisphere would provide detection and warning of attacks launched from the water areas adjacent to the North American continent. The HASP would provide timely detection and accurate description of the launch location and the number and type of boosters employed in the attack. Observational data would be obtained by the HASP sensors viewing the radiant signature of the rocket engine during its boost phase. The HASP would not observe small vernier or attitude control engine burns used to adjust the missile's trajectory, principally because the amount of energy emitted by such propulsion systems is below the attainable sensor sensitivity. HASP would also be unable to observe payloads; therefore, this sensor would not be expected to provide accurate trajectory or impact prediction. Equipped with nuclear burst detection sensors, the HASP would provide strike and preliminary damage assessment by describing the location, altitude, and yield of friendly or enemy weapons. Data from the HASP would be relayed to survivable computational processing centers in the U.S. for near real-time compilation of the information elements and transmission to the NCA and unified and specified force commanders. It is encouraging to note that HASP feasibility has been demonstrated.

* Low Altitude Surveillance Platforms.

A number of low altitude surveillance platforms (LASP) would provide global coverage for post-boost observation of orbits and trajectories. The LASP design precludes viewing missiles during the boost phase; therefore, it could not accurately determine the launch location or type of booster. LASP observations supplement HASP by providing supplementary detection and accurate prediction data on orbits and trajectories of individual threat objects.

* Space Object Inspection.

A space object inspection system (SPOIN) is necessary to monitor a potential aggressor's space developments and operations. USAF programs for space object inspection and negation have been proposed and rejected repeatedly over the past several years. The central theme of disapproval has been the USSR response and possible escalation by both nations. Other mission activities beyond inspection and negation of potentially hostile satellites have not been given proper emphasis. Inspection of failed U.S. satellites, logistical support of the Manned Orbiting Laboratory (MOL), and international cooperation and rescue are other operational applications of the technological capabilities of a space object inspection system. Despite the risks of a Soviet response, inspection is needed to fill critical voids in our threat estimates and to hasten recognition of new enemy capabilities. If the USSR deploys an armed satellite system for blackmail, propaganda, or tactical purposes, a U.S. reactive response which sought to create an inspection or negation capability after-the-fact could be "too little, too late."

Continued experimentation by the Air Force and industry has established the feasibility of space-based inspection for nuclear materials under most operational circumstances. Industry, in support of NASA programs, has also created a wide variety of dependable remote maneuvering spacecraft, with sufficient propulsion and cargo capacity to perform the inspection and/or nonnuclear negation mission. Advances have also been made in photographic, optical imaging, and electronic collection devices to complete the spectrum of technical intelligence data collection needed for space-based inspection. Present ground-based techniques for collection of such data are limited by distance, environmental effects, lack of definition, and gaps in coverage.

The space object inspection (SPOIN) system will consist of an inspector vehicle supported by the surveillance system's target tracking and trajectory prediction capabilities, real-time communications and command and control. The vehicle will be equipped with cameras to obtain high resolution pictures of target satellites when passing in their proximity, plus nuclear sensors, electromagnetic radiation sensors, infrared signature mappers, and a negation capability. The vehicle, designed for long life on orbit, will be equipped with an on-board target acquisition and tracking sensor and a command control system capable of receiving and acting on intercept data provided by the surveillance system. The inspector vehicle would be equipped to accumulate and transmit data to an appropriate collection point. Routine deployment of the system will consist of one SPOIN vehicle in a low polar orbit and a second vehicle on ground alert. Two modes of inspection are available: fly-by and rendezvous.

The vehicle in orbit will normally be quiescent awaiting mission assignment. On a fly-by mission the SPOIN can accomplish one-inch resolution images, electromagnetic radiation detection and passive nuclear materials sensing on each encounter with the target. Many inspections of each of a series of targets are provided in this way by utilizing various transfer maneuvers. In those cases where time is of the essence, a reaction time of the order of one to three hours can be obtained at the expense of subsequent inspection of other targets.

The coorbital intercept mode of operation will be performed by launching the vehicle in phase with the target. It will provide 1/8th inch image resolution, passive nuclear materials sensing and active weapon investigation. The coorbital mode will be limited to inspection of one target normally, but will provide much more detailed and sophisticated data. The enemy satellite can be destroyed or rendered harmless in the rendezvous mode, and in the fly-by mode if the pass is sufficiently close. A hypervelocity, nonnuclear kill mechanism would normally be employed, although a nuclear weapon could be used to increase the kill radius for the fly-by mode.

DEVELOPMENT REQUIRED

The surveillance system described above appears to be attainable from U.S. space technology advances over the past decade, and research and development programs under way or proposed. Illustrative of what remains to be developed and tested are: HASP and LASP sensor and electronic circuit hardening methods for survivability from nuclear effects; construction of lightweight decoys possessing physical characteristics similar to the respective surveillance sensor; component reliability to extend the space life of the sensor before failure; and on-board survivable data processing and transmission systems. To provide a communications net for HASP and LASP data, satellite control satellites with high gain, accurate pointing antennas; and survivable on-board processing equipment require priority attention.

Satellite-based surveillance systems offer many advantages over ground systems. They avoid foreign basing and overseas expenditures; lessen the vulnerability to sabotage; require less people to operate; and, in an emergency, can be replaced or modified without the down time characteristic of ground systems. Overall, it appears that satellite-based surveillance and communications systems will shortly prove more cost effective and more operationally desirable than ground systems. These considerations, plus the current lack of suitable surveillance or defense systems, offer ample incentive for aggressive development programs aimed at achieving a USAF capability in national defense.

PEACETIME CONTRIBUTIONS

Thus far, the importance of space-based surveillance in war has been emphasized; however, there are peacetime benefits as well. Space-based surveillance would provide the continuous reconnaissance needed by the United States to support our international space agreements and commitments.

With our continuing global surveillance capabilities, early detection and identification, as well as timely and accurate assessment, of new enemy threats would be feasible. Peacetime development activities by the potential aggressors to acquire new capabilities to counter the surveillance system would be observed. Recognizing this, the aggressors would be forced to include equally complex concealment techniques during development, or risk deployment without testing.

THE SENTINEL SYSTEM

As the system presently proposed for the nation's antiballistic missile (ABM) defense, SENTINEL has several limitations, some of which are inherent in the system design, and others of which result from force size constraints and system orientation. Design problems include limited surveillance and interceptor ranges and radar blackout from nuclear detonations. The system's orientation to the CPR threat largely negates its flexibility for defense against other threats such as that of the USSR, unless its configuration is increased significantly above current authorizations. To overcome these limitations, and to help plug the existing gap in USAF capabilities to defend the U.S., the Army has instituted studies and development in many of the surveillance areas discussed earlier and in performance improvements to its missile interceptors.

USAF PROPOSALS FOR MISSILE AND SPACE DEFENSE

What practical and economical missile and space defense concepts can the Air Force advance which would have the right combination of complementary defense capabilities? What concepts will be effective against the expected threat; possess the growth and flexibility for application beyond the visible future; and have the capability and mobility to operate in support of crises, small and large, and in austere forward-basing situations?

Minuteman II Offense/Defense Concept

The USAF has recently proposed to the Secretary of Defense the use of MINUTEMAN II/Mark 11 in a dual offense, defense role. This proposal advances the use of MINUTEMAN II/Mark 11 as an area interceptor for defense against missile attacks on CONUS. The system's capabilities against the CPR threat are nearly double SENTINEL's alone; fatalities are significantly reduced; and costs, over a 10-year period, are less than one-half those currently predicted for SENTINEL. An important feature of this proposal is that the MINUTEMAN II/Mark 11 capability can be made available nearly two years earlier than the currently considered SENTINEL deployment.

Surveillance for threat and for MINUTEMAN interceptor engagement can be provided by a combination of forward-based Perimeter Acquisition Radars (PARs), also used in the SENTINEL program, and Ballistic Missile Early Warning System (BMEWS) radars. Options for the command and control of MINUTEMAN II/Mark 11 in a dual role mode are in the early stages of formulation and study in the Air Staff at this time.

Airborne Ballistic Missile Intercept System (ABMIS)

The ABMIS is a promising candidate for an active missile and space defense role. The concept utilizes an aircraft equipped with interceptor missiles and autonomous surveillance devices for missile employment. With on-board target acquisition sensors and interceptors, augmented by the space surveillance system discussed earlier, it could be employed in an active defense role on a global basis. Its potential for the selective defense of CONUS, overseas commands, or our Allies is a significant improvement over land- or sea-based limited range systems.

Its inherent flexibility and mobility offer unique advantages against a wide spectrum of threats and would avoid permanent overseas basing and resultant problems of negotiation with foreign countries, construction, and gold flow. It is adaptive to terminal or perimeter defense against the ICBM, IRBM, and SLBM threats. It appears to have potential for satellite negation and in this role avoids the problems of fixed sitings against anticipated orbits.

The Weapons Systems Evaluation Group found ABMIS to be a cost effective concept against the SLBM threat.

The Air-Cushion Concept

A recent study identified a preliminary missile and space defense concept based on use of the air-cushion vehicle as a prime mover. Figure 1 provides a pictorial illustration of the system. The vehicle would be equipped with an appropriate radar design for target acquisition and discrimination and on-board missiles to engage and destroy threat objects. Deployed from support bases in the Arctic, the air-cushion vehicles would operate within designated areas of the North Polar region— their mobility allowing frequent change of position to avoid targeting by the enemy. Satellite navigation systems would be

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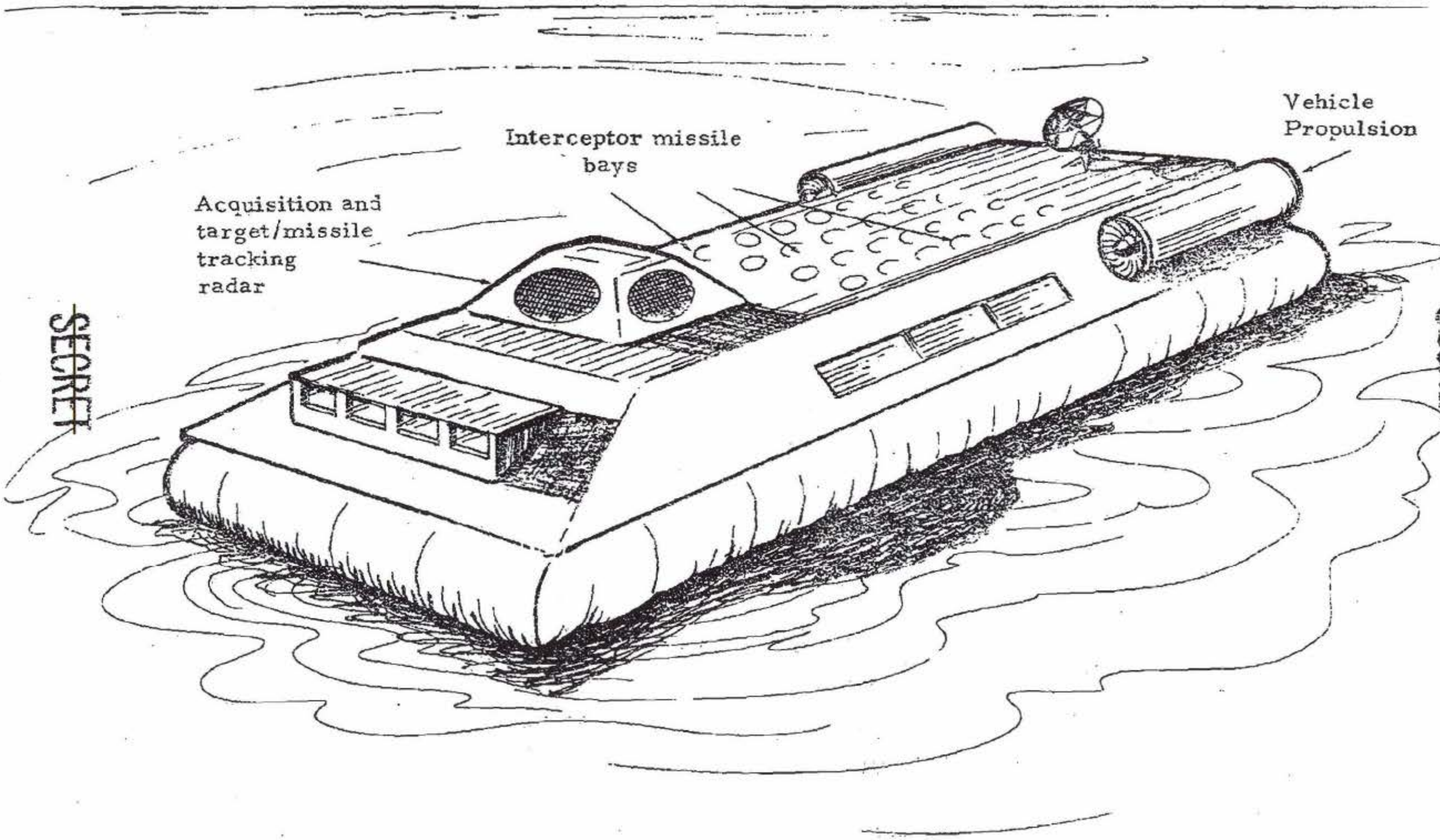
Figure 1: AIR-CUSHION VEHICLE



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used to assure all-weather, precise positional information. Assuming the concept is feasible, it would also have counterbattery attack capabilities. The short distances to Soviet targets from the polar locations would minimize the time available to the enemy for offense or defense reaction. The convergence of Sino-Soviet ballistic missile and northerly launched FOBS trajectories over the polar region indicates that adequate missile and space defense coverage could be acquired with a few air-cushion vehicles. Further study of this concept may reveal that the formidable problems associated with the basing of nuclear weapons on the Arctic icecap, restricted mobility under Arctic weather conditions, and limited growth potential make the concept impractical. However, the concept should not be discharged until all of its advantages and disadvantages have been examined in detail.

Nonnuclear Kill

Nonnuclear kill of threats well beyond our national borders would provide an attractive alternative to proposed nuclear destruct engagements which would normally occur over an adjacent neutral or friendly country. In a general war, nonnuclear capabilities would virtually eliminate problems of fratricide of our friendly offensive missiles by the defense; and reduce the need for complex coordination and control between the forces. From the standpoint of operational test and evaluation, the benefits are manifold.

Air Force development programs have identified two promising concepts which could provide this obviously desirable capability. Both programs have been active for several years, and are under close review by OSD. Both concepts employ a MINUTEMAN booster to place the interceptor vehicle on a closing trajectory with the target. In one concept, interceptor proximity fuzing and release of many hundreds of steel fragments in a pattern covering the target assure kill by hypervelocity impact. The combined target/interceptor closing velocities would range from 10,000 to 40,000 feet per second. Many ground tests have been made to study the effectiveness of hypervelocity kill techniques. In still another concept, many small (approximately two-pound) sensors would be placed on an attack trajectory with an incoming target by the booster/interceptor vehicle. At the proper time and distance, the sensors would be dispersed in a pattern to encompass the possible target area. The individual sensors search and track targets in their fields of view, and with small propulsion units maneuver to eliminate target relative motion. Hypervelocity impact of the sensor with the target provides the kill mechanism. Such an intercept technique would be well suited to sophisticated threats employing combinations of countermeasures and multiple targets.

High Energy Systems

Based upon the rapid progress in laser development over the past several years, it is now conceivable that in the early to mid-1970's, defense applications will reach a practical stage. Other discoveries through research have shown that such directed energy devices may be useful as negation or destruction weapons. Laser, or similar devices, mounted on platforms outside the dense atmosphere, could be the next generation sensor and weapon systems for the accurate tracking, imaging, discrimination, and negation of satellites and reentry vehicles, offering thereby an excellent defense against Multiple Independent Reentry vehicles (MIRVs).

Consolidation of Aerospace Defense Capabilities

A valuable undertaking, with a potentially high payoff, would be a study to combine existing or planned systems and methods to cope— in concert— with the combined threat. As an example, a second generation merger of the Airborne Early Warning and Control System, currently being developed, with the ABMIS concept discussed earlier, might well produce a capability usable over the entire threat spectrum. In the face of rising costs for development and production of new systems, and our natural tendencies to deal with problems incrementally, such an approach might prove both feasible and cost effective.

SUMMARY

The near and distant regions of space provide almost limitless possibilities for an aggressor nation that chooses to exploit them for political and military purposes. While today's technological capabilities may appear to serve the peaceful uses of space, the effective military applications cannot be ignored. We cannot rely exclusively on political interpretations of Sino-Soviet intentions for vigilance in advocating concepts or acquiring capabilities in space; nor can we always be placed in a reactive position to the capabilities of the Communist countries. The nation that gains a preeminence in military space technology and operational capabilities, and clandestinely exploits those capabilities, may well be in a position to control the use of space.

By capitalizing on the current United States advantage in space technology, significant contributions to national security can be provided by the Air Force. Coverage, survivability, and performance attributes afforded by space-based missile and space defense surveillance systems exceed those attainable from land or sea basing. Assuming the operational life of space systems can be extended, land or sea basing is not cost competitive. Residually, foreign country agreements, overseas construction and investment with its resultant gold flow and deficit payments, along with personnel manning, training and replacement requirements, all are significantly reduced.

Considerable work remains to be done in selecting a promising mix of long-term, cost effective missile and space weapons contenders. With well-defined goals, searching analyses and aggressive advanced development programs, the Air Force can, and must in consonance with its mission, make valuable contributions to this vital area of national security. The contributions to defense advocated in this paper will add to our national policy of deterrence through strength. They will help to insure that space is maintained for peaceful purposes and that no nation secures a capability in space which can threaten the security of the United States and the free world.

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