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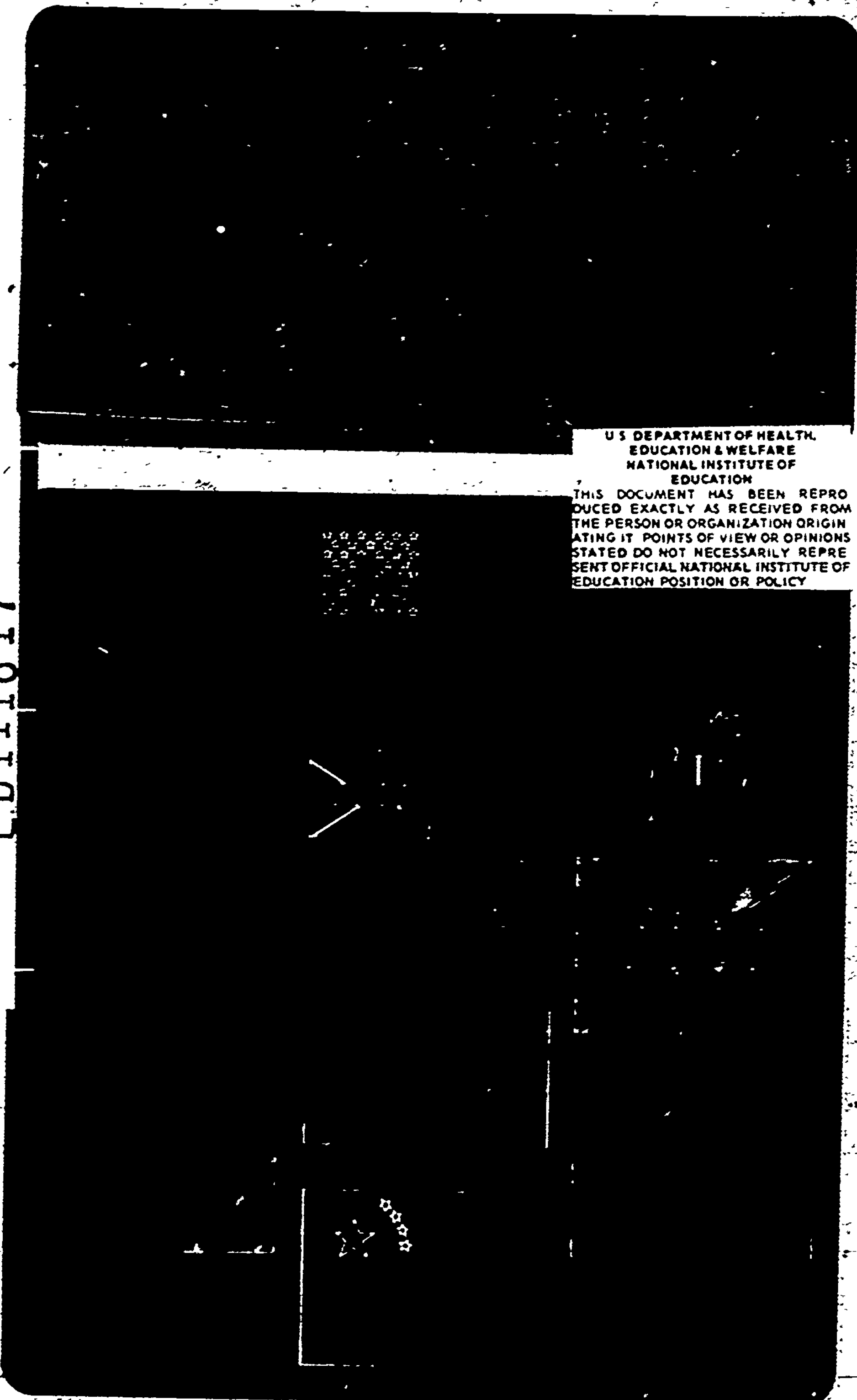
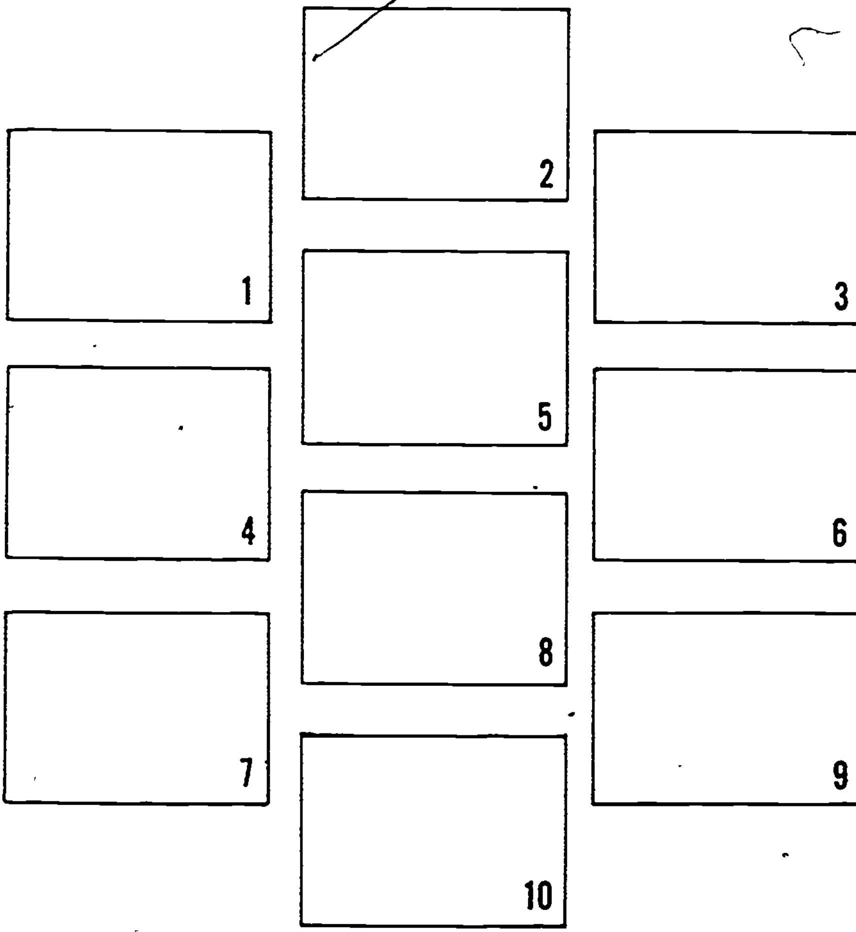
ABSTRACT

This book, one in the series on Aerospace Education III, is a collection of the diverse information available regarding the international space programs. The five goals listed for the book are: to examine the Soviet space program, to understand the future of Soviet space activity, to examine other national and international space programs, to compare the advantages and disadvantages of joint and independent space efforts, and to review some of the international agreements and laws governing space exploration. The book is designed to be used in the Air Force ROTC program. (PS)





ON THE COVER

Flags of the ten nations who have placed satellites in orbit since the beginning of the space program. They are, in order of that achievement, 1) USSR; 2) U.S.; 3) Canada; 4) Italy; 5) Australia, 6) Britain; 7) France; 8) West Germany; 9) Japan; 10) People's Republic of China.

Aerospace Education III

International Space Programs

S. B. BULMER
3825th Academic
Services Group

AIR FORCE JUNIOR ROTC
AIR UNIVERSITY
MAXWELL AIR FORCE BASE, ALABAMA

1973

This publication has been reviewed and approved by competent personnel of the preparing command in accordance with current directives on doctrine, policy, essentiality, propriety, and quality.

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This book will not be offered for sale. It is for use only in the Air Force ROTC program.

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We gratefully acknowledge the contribution of 2nd Lt Bill D. Brink, AE Course Director, AFJROTC, to the development of this text.

Preface

The space age began in 1957, with an 83-kilogram Russian satellite beeping greetings to a startled world.

John E Naugle
NASA

IT IS IMPORTANT to remember that the United States was not first in space. Even today, with giant steps and golf shots on our side, it is important to remember that in the face of our shrinking program the Soviet program is expanding. At the same time approximately 80% of the nations of the world have joined the search. Indeed, it is quite possible that, in the future, the majority of significant breakthroughs will come from outside our national program. The mastery of space is truly a world-wide project. Any student of space or space exploration will find it a necessity to understand these space programs.

Unfortunately, few students have accomplished the task of understanding other national and international space programs. One important reason why has been the degree of secrecy concerning the Soviet space program. Another is the diversification of information on programs outside the United States. The news media emphasize the development and history of our space shots and, in contrast, make only an occasional announcement of a launch by other nations. The resulting erratic disposition of information and material makes it impossible for the average reader to accurately follow worldwide space programs.

It is the purpose of this text to collect the diverse information currently available and present it in a readable form. This purpose is to allow the student to accomplish five goals; these are:

- to examine the Soviet space program;
- to understand the future of Soviet space activity;
- to examine other national and international space programs;
- to compare the advantages and disadvantages of joint and independent space efforts;
- and, finally, to review some of the resulting international relations, agreements and laws that have grown from space exploration.

Contents

The Soviet Union in Space

THIS CHAPTER deals with the foundations of the Soviet space program. More specifically, it deals with Soviet motives and the resulting launch sites and launch vehicles. Upon completion of this chapter, you should be able to: (1) outline the motives of the Soviet Union for beginning a space program; (2) list the Soviet launch facilities, their uses, and their US counterparts; and (3) list the Soviet launch vehicles, their origins, uses, general lift capacity and, US Counterparts.

TSIOLKOVSKY'S DREAM

The Russian people claim **Konstantin E. Tsiolkovsky** (Fig. 1) as the founding father of astronautics (space travel), just as Americans honor Robert Goddard as the father of rocketry. Tsiolkovsky, perhaps no less than Goddard, performed essential early work in the science of rocketry and is acknowledged around the world as an important pioneer in that field.

The Soviet Union's interest in space technology can be traced to work by Tsiolkovsky in the late nineteenth and early twentieth centuries. The Russian imagination was captured by his prediction: "Mankind will not stay on Earth forever, but, in the pursuit of light and space, will at first timidly penetrate beyond the limits of the atmosphere and then conquer all the space around the sun."

Russian interest in making that prediction come true was not lacking. Tsiolkovsky's disciples continued to work in the field that he had opened to them, and, in 1924, an organization called the Central Bureau for the Study of the Problems of Rockets (later known as the Group for the Study of Reactive Motion) was formed. This Russian rocket society, with chapters in Moscow and Leningrad, came into being three years before the first rocket society was organized in Germany.

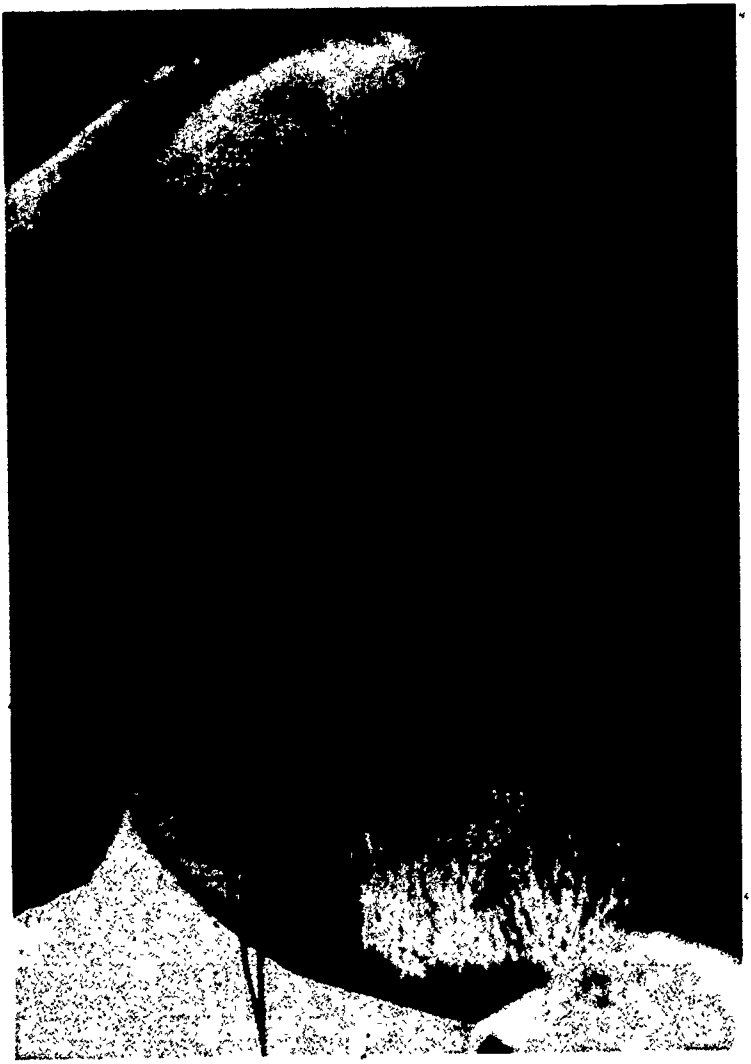


Figure 1. Konstantin Eduardovich Tsiolkovsky, born 1857, died 1935; "The Father of Astronautics."

The Soviet Government began a program of rocket research in 1934, the same year that Goddard unsuccessfully tried to interest the US Government in rocketry. Official US interest in rocketry was not aroused until the eve of World War II. As a result, when both nations began active rocket programs, the Soviet Union had already fashioned a lead.

The posture of the Soviet Union after World War II had considerable impact on Soviet interest in space exploration. Although the Soviets made tremendous technological advances during World War II, as the war ended, Soviet technology was still backward in many areas. The United States had a monopoly on A-bombs, and even the defeated Germans led the world in rocket technology. The chance that these two developments might be joined put the Soviets even further behind. For the relatively young Communist government, such developments were critical. The Soviet Union, therefore, launched the first all-out space program, determined to put the Union of Soviet Socialist Republics into space ahead of the rest of the world. Soviet leaders hoped that, in the process, the Soviet Union's place as a world power would be enhanced.

Both Soviet and American rocket programs benefited from the capture of German scientists and V-2 rockets at the close of World War II, but the Soviets pursued their own program with greater intent. As a result, on 4 October 1957, the first phase of Tsiolkovsky's dream came true. "Mankind. . .in pursuit of light and space began to timidly penetrate beyond the limits of the atmosphere . . ." as Sputnik 1 (Fig. 2) circled the earth.

SOVIET LAUNCH SITES

Before the Soviets could begin to develop a space program, they needed to develop a system for command and control and a stable of launch vehicles. The system of launch and control sites (Fig. 3) includes a command center (like the US Houston Control) at **Baikonur,** a manned spacecraft center (like the Houston Center) at **Zvezdny Gorodok** with three launch centers **Tyuratam, Kapustin Yar** and **Plesetsk.** In the facility at Kapustin Yar, where the Soviets brought the captured German technicians,

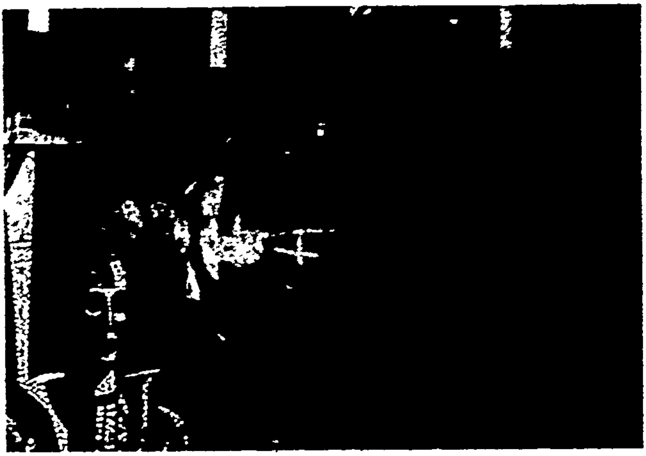


Figure 2. Copy of Sputnik–1 holds a place of pride in Tsiolkovsky Museum of Astronautics in Kaluga.

they developed the necessary technology to launch a sputnik (satellite). With this advancement, the command to launch was given at the Baikonur Cosmodrome.

Tyuratam

In response to the launch command, the first satellite **Sputnik 1** was launched from an unknown point in the Soviet Union. Japanese scientists were the first to figure out the general location of the launch site. They said that it was east of the Aral Sea, and not at the rocket test site at Kapustin Yar on the Volga River. When the Soviet Union later announced the launch, they claimed that it originated at the Baikonur Cosmodrome. However, later ground traces geographically placed the real site 230 miles southwest of Baikonur at Tyuratam.

The first US launch site was Cape Canaveral (Cape Kennedy). The Cape has grown into a vast complex used largely for research and development and NASA manned launches. The same history applies to Tyuratam. From its cosmodrome, Soviet scientists and engineers handle manned space launches and conduct research and development.

Kapustin Yar

As the US program expanded its activities, Cape Kennedy became so busy that, in time, requirements arose for a simpler facility, that would be closer to the scientists at Goddard and Langley Space Centers. The answer was the Wallops Island launch site, which handles only Scout launch vehicles and smaller rockets.

The Soviet Union probably had the same problems because the Soviet space authorities began space launches with smaller vehicles from Kapustin Yar. When the Soviets announced the launch of Cosmos 1 (see chapter 2 for discussion of the Cosmos series), the ground trace of the first orbit went right through their old testing ground at Kapustin Yar.

The United States has one other important suborbital launch site at White Sands, New Mexico, which is used for firing V-2, Viking, and Aerobee rockets. The Soviets use Kapustin Yar for similar geophysical and biological payloads.

Plesetsk

As time went on, the United States needed a launch site for polar orbits. Polar orbits are necessary for worldwide coverage in applications flights such as weather satellites. Also, many military flights needed the angle of launch and privacy of a third launch site To solve the problem, launch facilities were located at the Vandenburg AFB-Point Arguello launch site. The west coast site met the launch azimuth (angle of launch) needs.

The same considerations probably influenced Soviet policy. When Tyuratam was sufficiently busy, Soviet authorities may have felt the need for a different site that would be more versatile than Kapustin Yar. Such a site could also be located closer to the Moscow laboratories. In 1966, military and applications flights began coming from such a new site. However, because it was US policy not to take the initiative in naming Soviet launch sites, the honor of identifying the new site was left to some British school boys at the **Kittering Grammar School** north of London. Becoming interested in space exploration, they had developed their own listening station. By listening to radio signals from spacecraft, they could carefully plot the **ground traces**. The boys even came to recognize when Soviet recoveries were in progress and

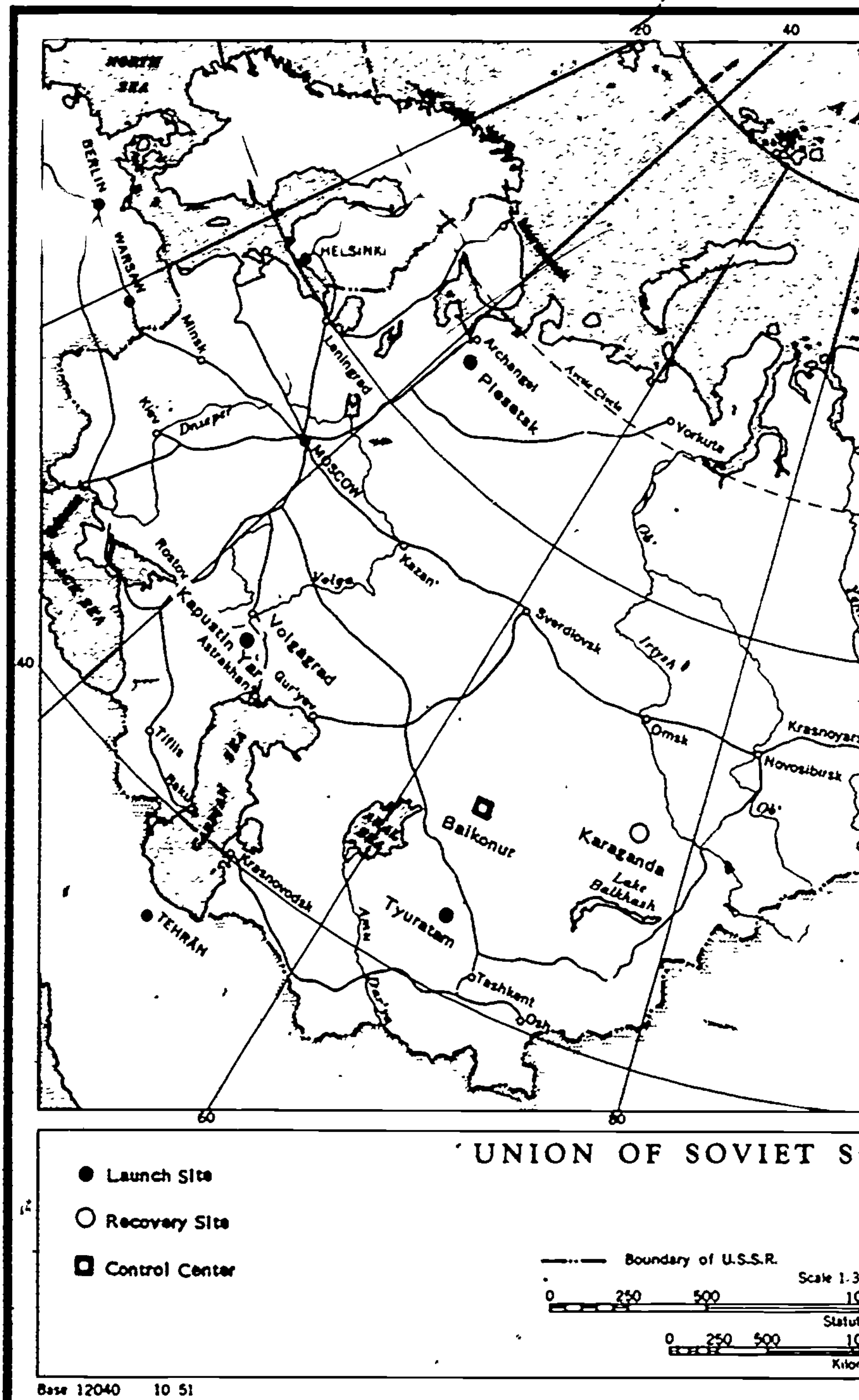
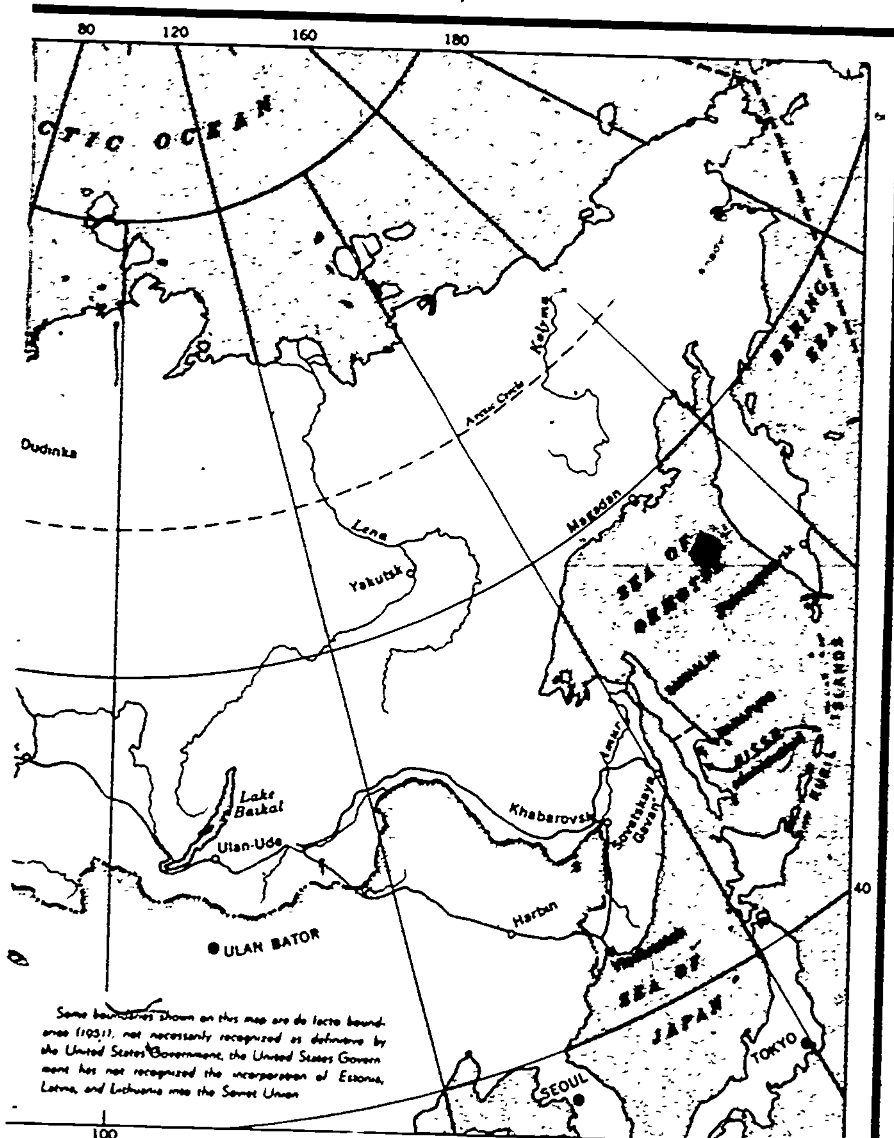


Figure 3. Map of USSR showing launch sites.



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what beacon signals came from the landing capsule. When the new launch site came into use, the Kittering boys spotted the new ground trace, however, lacking precise information about the time of the launch, they were unable to pinpoint the site. Another launch from the Soviet's new site had a different **inclination*** (angle to the equator). By crossing the two ground traces of the first orbits (Fig. 4) the Kittering boys were able to approximate the location of the launch site. It was near the town of Plesetsk; the launch site was given the same name.

Zvezdny Gorodok

Zvezdny Gorodok, which means Stellar Town but is usually translated as Star City, is in many respects the Soviet equivalent of the Manned Spacecraft Center in Houston, Texas. Star City is located approximately 25 miles northeast of downtown Moscow, hidden by a forest of fir and pine. The training center is completely self contained, with modern high-rise apartments, a school, a hotel, a small shopping center, and, of course, the "house of culture." The tiny city of 1,500 to 2,000 (this varies according to mission requirements) is dominated by a large bronze statue of **Yuri Gagarin,** the first man in space.

The training area is separated by forest and a large green board fence. Here are located a classroom building, spacecraft simulators, gymnasium, athletic field, medical center, office building, and living quarters, where the cosmonauts stay during postflight examinations.

American space officials who have been permitted to visit Star City have reported that training there follows "principles similar to ours." There are three areas of major emphasis. First is what the cosmonauts call the "devil's merry-go-round." This is a large centrifuge that revolves and spins to test the cosmonauts' resistance to increased G-forces (gravity pull) associated with launch and reentry. Second, in a separate building, the cosmonaut is taught to maintain his balance and perspective in extreme situations. This is accomplished by placing the cosmonaut in a chair

*The inclination, or angle to the Equator, of a launch is critical to the programmed function of the launch. As will be seen in later chapters, some satellites require a 0° inclination (Chapter 4, India and Brazil) while others must combine an inclination of 65° with an elliptical orbit to be functional (Chapter 2, Molniya).

in the center of a large cylinder. The walls of the cylinder are painted with black and white stripes creating various optical illusions. As the cylinder is rotated, the cosmonaut is required to keep his balance and remain sitting straight up at all times. The final area of major empahsis is parachuting. Although this is no longer a backup system in case a soft landing attempt fails, the Soviets emphasize it as a test of one's ability to handle high-stress situations.

SOVIET LAUNCH VEHICLES

Before the Soviet Union established its commitment to the exploration of space, the Government committed the country to the task of mating the German advances in rocketry to the American developed atomic bomb. As a result of these activities, the Soviets had an effective Intercontinental Ballistic Missile (ICBM) potential. When the decision was made to enter into a space program,

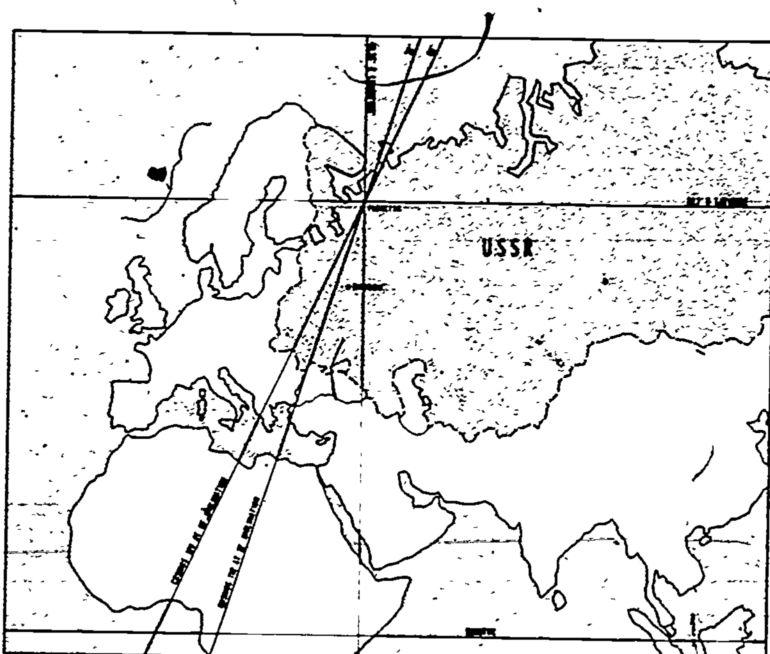


Figure 4. Ground traces lead to Plesetsk.

the military ICBMs already developed became a ready source of launch vehicles. As a result, the series A,B,C, and F launch vehicles are converted ICBMs, Intermediate Range Ballistic Missiles (IRBMs) or Medium Range Ballistic Missiles (MRBMs). Only the series D and the series G launch vehicles are of civilian origin. The series G, as of 1972, had yet to record a successful launch; and the series D has never proven reliable enough for it to be **man-rated** (rated safe enough to carry manned payloads). In contrast, the United States, with the exception of the Redstone launch vehicle, developed an almost entirely civilian booster series. Figure 5 shows the entire stable of Soviet launch vehicles for orbital and escape space flights.

The Standard Launch Vehicle (Series A)

The Soviet adaptation of the 1957 SS-6 Sapwood ICBM is still the mainstay of the Soviet program. It has been used from Sputnik 1 to the latest Soyuz mission, accomplishing more orbital launches than any other vehicle in the world (Fig. 6).

In the early years of the space age, many unusual stories arose about the Soviet launch vehicles. Because of Soviet secrecy, the United States could only guess what the Soviets were using. Faced with the mystery of what the Soviet launch vehicle was like, many views were offered. The earliest testimony from US officials estimated that the vehicle had a thrust of 200 to 300 thousand pounds. But, as time passed and the weight of the payloads increased, estimates were raised to 800 to 900 thousand pounds. This was about two and one half times the thrust of Atlas or double the thrust of the Titan II first stage. When the Soviets filed the claim for a world flight record with the Federation Aeronautique Internationale (FAI) in Paris, they stated that the combined thrust of all stages was 600 metric tons. This meant a total thrust of 1,323,000 pounds, a capability that the Soviets possessed as early as 1957.

FIRST PUBLIC VIEW.—It was not until 10 years after Sputnik that the complete series A vehicle was unveiled at the Paris air show in 1967. It was composed of a hammerhead core vehicle with four large strap-on boosters, an upper stage, and a **Vostok** spacecraft on the top. It was so sturdy that it was quite consistent for the core plus strap-ons to have a thrust of over one million pounds. From these bits and pieces, one can now reconstruct the Soviet advantage with the large standard vehicle. While US space officials were working with 20-pound Vanguard payloads, the Soviets were planning in terms of tons.

The other surprise at Paris was the simplicity of the whole system. It was reminiscent of the unofficial von Braun symposium plans (published in 1952) for a multi-nozzled rocket. The Soviet vehicle not only had a core with four strap-on boosters, but each of these units had four exit nozzles. The 20 nozzles (Fig. 7) did not **gimbal** (move for steering purposes) as do the nozzles on US rockets but, instead, relied upon small control nozzles for guidance.

IMPROVED UPPER STAGE (A-1).—Later, another upper stage was developed and the Series A vehicle was then capable of putting 14,000 pounds in orbit, sending 3,500 pounds to the Moon, or sending 2,400 pounds to the planets. As filed with the FAI, this improved standard vehicle (A-1) was described as having a combined total thrust of 650 metric tons or 1,433,250 pounds.

The Small Utility Launch Vehicle (Series B)

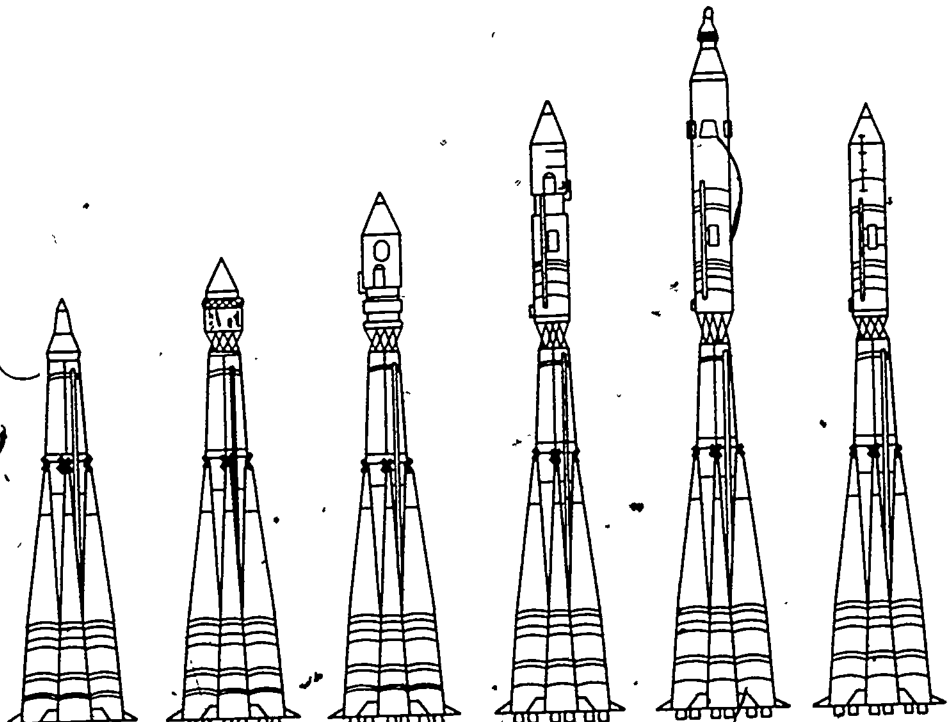
When the Kapustin Yar site came into use, an existing intermediate range missile with a suitable new upper stage was needed to lift the modest payloads. Since the British classed these payloads within the range of a missile similar to the US Thor, it was easily identified as an adaptation of the SS-4 Sandal MRBM, of 1963 Cuban fame. By modifying the Sandal for space flight, the Soviets developed the Series B launch vehicle, and by adding an upper stage, the B-1 (Series B plus upper stage) was developed. The Series B is also referred to as the **Cosmos vehicle,** the **Kapustin Yar small vehicle,** and the **KY-launch vehicle.** The B-1 can lift up to a 600-pound payload and is used at both Kapustin Yar and Plesetsk.

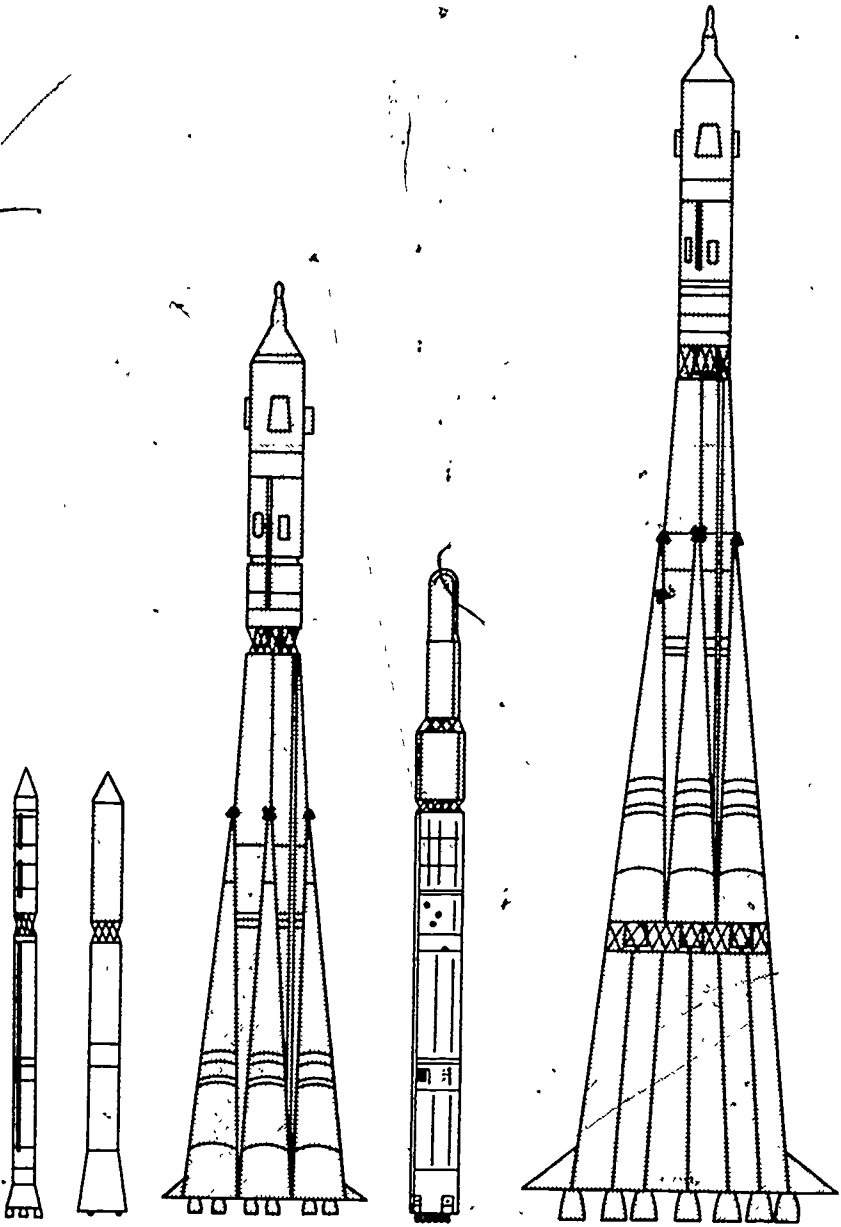
The Flexible Intermediate Launch Vehicle (Series C)

Something more efficient than the Series A and more versatile than the Series B was needed for intermediate payloads launched at Tyuratam and, later, at Plesetsk. To this end, the Soviets modified the SS-5 Skean IRBM, which is capable of lifting as much as

Figure 5. Soviet Launch Vehicles— left to right: "A" vehicle with early Sputnik payload; A–1 vehicle with early Luna payload; A–1 vehicle with Vostok payload; A–2 vehicle with Voskhod payload; A–2 vehicle with Soyuz payload; A–2–e vehicle with deep space payload; B–1 vehicle with small cosmos payload- C–1 vehicle for intermediate cosmos payload, upper stage is postulated; D–1–e vehicle is postulated; F–1–r/m vehicle for FOBS and interceptors, upper stages postulated; G–1–e vehicle, postulated.

POSTULATED





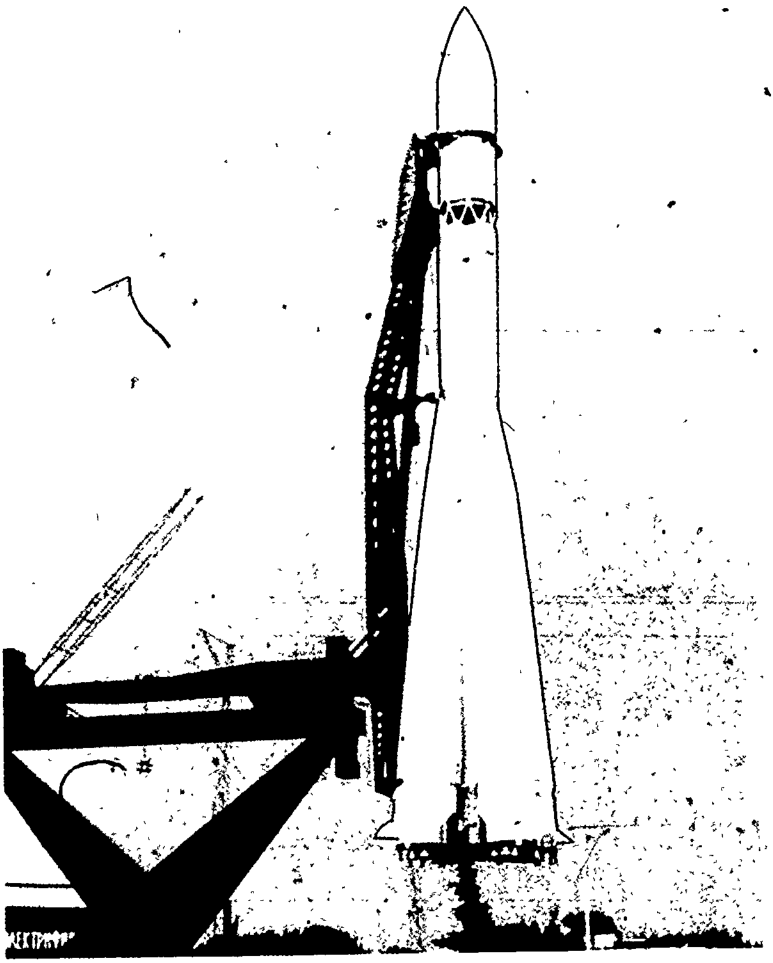


Figure 6. Series A launch vehicle.

2,000 pounds into orbit. It is capable of attaining circular orbits at various altitudes.

The Non-Military Large Launch Vehicle (Series D)

Due to their limited potential, military missiles were only interim boosters as space plans became more ambitious. In this country, the National Aeronautics and Space Administration (NASA) developed Saturn with a total thrust of about 1.5 million pounds and then upgraded to Saturn V, in 1967, with a first-stage thrust of 7.5 million pounds. This was followed by a second-stage rocket with 1 million pounds of thrust and with a third stage having 200,000 pounds of thrust.

The Soviet Union has been proud of its operational lead in lifting power. While US space officials were still using Thor and Atlas vehicles for larger payloads, the Soviets were using the Series A of far greater capacity. They were also fully aware of US progress in the Titan III and Saturn family. And they announced that they were undertaking far more ambitious space flights. This strongly suggested that the world should expect to see a larger

Figure 7. Series A multi-nozzle engines.

vehicle appear on the scene, and, in the summer of 1965, it did. Used to launch the **Proton** satellite series, the new booster was soon known by the same name. At first, the Series D (Proton) had an estimated 3 million pounds of thrust, then, in November 1968, the Series D was upgraded to an estimated 3.97 million pounds of thrust, with the addition of an improved upper stage (D-1).

The Military Combat Launch Vehicle (Series F)

As the Soviet military space program advanced to include such weapons as interceptor/destructor satellites and **fractional orbit bombardment satellites** (FOBS) (see chapter 2), still another military carrier was pressed into service. The SS-9 Scarp ICBM was adapted for space launch. By adding an upper stage (F-1) and placing it in a hardened silo with a FOBS war head (F-1-r), a completely new dimension was added to Soviet offensive power.

The Super Booster (Series G)

The Soviets are now working on a super booster. Its primary purpose will be to place in orbit the core of the Manned Orbital Platform (MOP). (See chapter three). The **Series G** has been reported to be a bullet-shaped rocket half as big again as the Saturn V.

The big booster, with up to 10 million pounds of thrust, has been plagued with misfortune since the summer of 1969. During a static test firing, the first prototype was damaged extensively by fire and explosion while still in pre-launch operations. It took Soviet engineers a reported 18 months to restore the launch site. In the summer of 1971, a violent explosion ripped apart the second prototype after it had reached an altitude of 12,000 meters during a test launch.

CONCLUSION

From the dream of Tsiolkovsky and the embarrassment of its backseat position in technology after World War II, the Soviet Union launched an aggressive space program. In space exploration, the decade of 1957-1967 was ruled by the Soviet Union with the United States a confirmed second. The year 1967 marked a reversal of that role as the United States became the world leader in lift capacity. However, US dominance in the second decade of space does not assure permanent superiority. If the Soviets overcome the difficulties which they are experiencing with their series G launch vehicle, it could mean another decade dominated by the Soviet Union.

WORDS, PHRASES AND NAMES TO REMEMBER

Konstantin E. Tsiolkovsky (kon-stahn-TEEN tsyahl-KOFF-skee)
Baikonur (bigh-kah-NOOR)
Zvedzny Gordok (ZVYAWZD-nee guh-rah-DAWK)
Tyuratam (TYOO-rah-tum)
Kapustin Yar (kuh-POOS-tin YAR)
Plesetsk (pli-SETSK)
Sputnik 1 (Satellite)
Kittering Grammar School
ground traces
inclination
Yuri Gagarin (yu-REE guh-GAR-in)
man-rated
vostok (vah-STAWK)
gimbal
Cosmos vehicle
Kapustin Yar small vehicle
KY-launch vehicle
Proton
fractional orbit bombardment satellites
Series G

QUESTIONS

1. Who is considered the "father of astronautics?"
2. List two factors that motivated the Soviets into undertaking a program of expanded rocket research and space exploration.
3. What are the names and locations of the Soviet equivalents of the following US facilities:
   a. Houston Control,
   b. Houston Manned Space Craft Center,
   c. Wallops Island,
   d. Cape Kennedy,
   e. Vandenburg AFB,
   f. White Sands?

4. Why did the Soviets enjoy an initial advantage over the United States in booster capability?

5. Name the origin of the six Soviet space vehicles.

6. What booster is believed to be the world's most powerful at the present time?

THINGS TO DO

1. Use styrofoam, wire, cardboard, or any other materials available to make models of the Soviet launch vehicles. Be sure to keep them in scale with each other, so they can be displayed as a model of the Russian stable of launchers.

2. On a map of the Soviet Union locate and mark the Soviet ground facilities Consult Appendix A, and then, by using the launch inclinations listed, plot the ground traces of various launches. After this is completed see if you can explain, using your map, how the Kittering Grammer School boys found Plesetsk.

3. Report to the class on other famous Soviet space pioneers and officials not mentioned in this text. Consider such names as Kondratiuk (kuhn-drah-TYOOK), Korolev (kuh-rahl-YOFF), Tukhachevsky (too-hah-CHEFF-skee), Tikonrovov (tee-hahn-RAH-voff), and Pobedonostev (puh-byeh-dah-NOST-yeff)

SUGGESTIONS FOR FURTHER READING

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U.S., Cong., Senate, Committee on Aeronautical and Space Sciences, *Soviet Space Programs, 1966–70*, 92nd Cong, 1st sess, 1971, Chapter 4.

THIS CHAPTER deals with the history of the Soviet space program. It examines three areas of program development: unmanned, manned, and military. Upon completion of this chapter, you should be able to: (1) list the Soviet space projects; (2) compare the "direction" of the Soviet space program with that of the US program; (3) outline the manner in which the developments and accomplishments of one project are used in later projects; (4) list the major Soviet "firsts in space"; (5) define the significance of such developments as (a) Sputnik 1, (b) Laika, (c) orbital launch platform, (d) Polyot project, (e) Vostok-Voskhod similarities, (f) the Cosmos cover, and (g) the deaths of Komarov, Dobrovolskiy, Volkov, and Patsayev.

The Soviet program has unfolded in an orderly way, building rather conservatively step by step with considerable economy of design. The greatest failing seems to have been in reliability of many payload components, but even those problems yield to determined attention. By now, the program has blossomed into a varied complex of mission goals as widespread as our own. It is pointed toward science and to practical uses for both the civilian economy and the military. How far in advance they may have planned all phases is not clear. Lead times in any important program certainly involve knowing 5 to 10 years in advance what is to come next. Alternation between success and failure and various budgetary rivals probably are essentially the same between the United States and the Soviet Union.

THE UNMANNED SPACE PROGRAM

When Soviet space flight began, there was only one program. It was the beginning of the unmanned program, and it consisted of three Sputniks and three Luna missions launched over a three-year period.

The Early Sputniks, 1957–58

On 29 July 1955, the United States announced that it intended to contribute to the coming International Geophysical Year (IGY) by putting a 20-pound Vanguard payload into orbit. A day later, the Russians announced that they had similar, though more ambitious plans, but most of the Western World hardly listened. When the shock of Sputnik 1 (Fig. 8) came on 4 October 1957, there were many who were sure at least that a decimal point had been misplaced when the weight was given as 184 pounds. More than anything else, Sputnik shook the complacency about the unbeatable lead of US science.

News of Sputnik 2 in November 1957 further shook the Western World when its weight was announced as 1,121 pounds, with an attached carrier rocket weight of over 5 tons. Also on board was the dog Laika (Russian for "barker"), from which for a

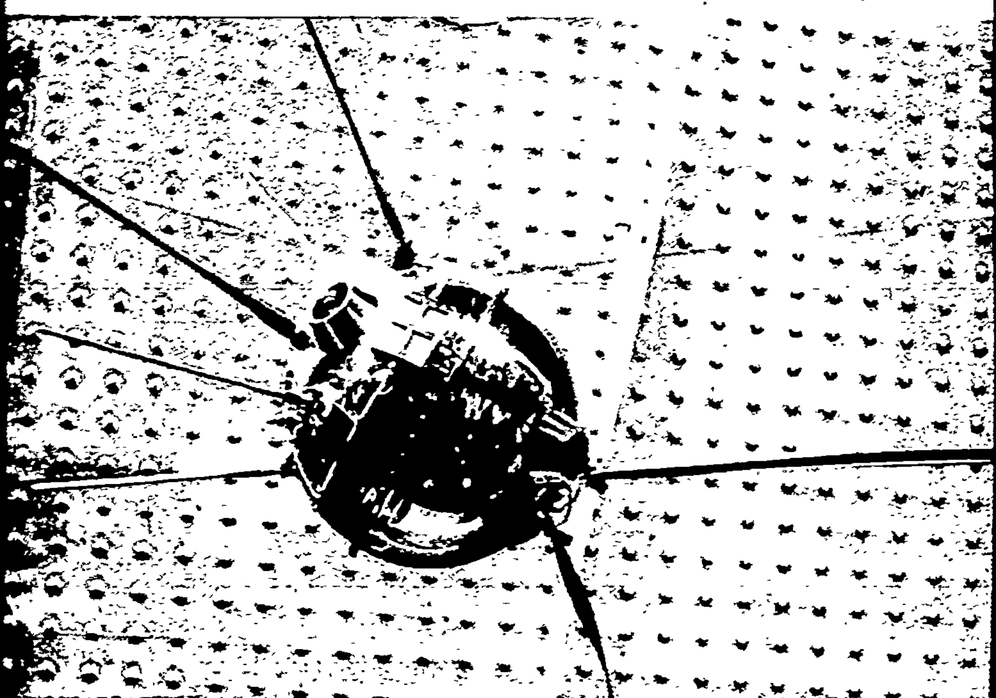

Figure 8. Sputnik 1.

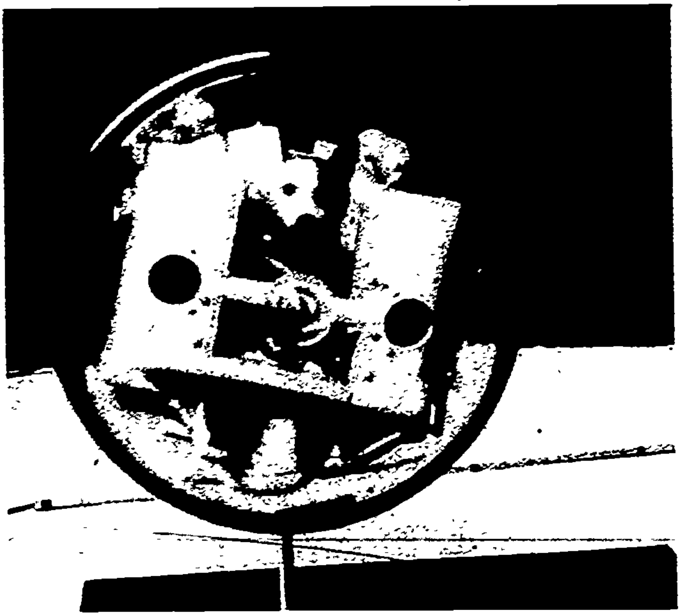

Figure 9. Sputnik 2: The Laika launch.

week were relayed to earth biological data on the effects of weightlessness, radiation, and other information (Fig. 9). From these studies came much of the basic data on which later manned flights were planned.

The deepening US feeling of depression was compounded the following month when the widely-heralded Vanguard fell back on its pad and exploded. The United States did not match the 1957 Soviet records for total weight in orbit in any payload until the Saturn 1 flight in 1964; further, the United States was unable to match the feat of orbiting a satellite for almost a year

The Russians were impressive with Sputnik 3. This, 2,926-pound orbiting geophysical laboratory was not matched by the United States from the time that it was launched in 1958 until the first US Orbiting Geophysical Observatory (OGO) flights in 1964. Sputnik 3 operated for two years until natural decay (the effect of friction and gravity) constricted its orbit, causing it to reenter and burn.

The Early Luna Flights, 1959

The next year brought the addition of an upper stage to the standard launch vehicle, greatly enhancing its capability. This improvement was first applied to the lunar program. Americans called these payloads luniks, and later, this Americanism was so catching that the Russians themselves began to use it.

The first of the Luniks was officially called Luna 1. Luna 1 was a pressurized spherical container with a minimum of instrumentation. Based on its high velocity and its contents, including various metallic emblems with the coat of arms of the Soviet Union, it was concluded that Luna 1 was intended to strike the Moon. However, its velocity was so great that, after its first pass at 3,700 miles, a slight bend in its trajectory (path) took it into a long flight around the Sun to become the first **artificial planetoid.** The United States made five lunar attempts in the Pioneer series. Pioneer 4, with a 13-pound payload, missed the Moon like Luna 1 and became the second artificial planetoid.

After many months, Luna 2 was launched and struck the moon 270 miles from its visible center—a well executed flight. The United States was unsuccessful in hitting the moon until Ranger 4 fell out of control on the far-side. The first fully successful US lunar mission was Ranger 7 in 1965 after nine Pioneers, two practice Ranger shots, and four lunar Ranger attempts.

Luna 3 (Fig. 10) was launched on the second anniversary of Sputnik 1 with the objective of passing near the far side of the moon by means of an intricate maneuver. A close pass was accomplished by launching Luna 3 from an orbiting platform rather than the earth. Since Luna 3 approached at a different angle than a launch from the earth, it could pass close to the far side of the Moon. It was equipped with a camera, which took photographs of the hidden side of the Moon. These photographs were developed automatically and then sent back to Earth through radio facsimile. The results were processed through a computer to translate some rather crude data into a fairly detailed map of craters on the far side of the Moon.

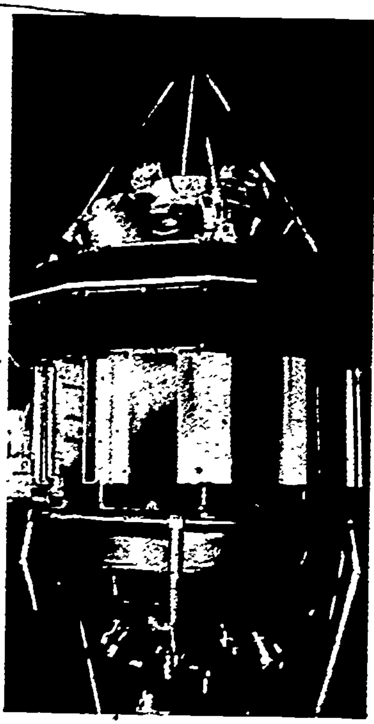

Figure 10. Luna 3.

The Near-Earth Program

As the Soviet space experts became increasingly more proficient in the area of space exploration, the Soviets began to specialize in mission goals and objectives. Specialization rapidly led to distinct programs with definable direction and purpose. However, this distinctiveness did not carry over into the labeling of programs. As a result, even though there were several unmanned near-earth programs, nearly all were encompassed within the Cosmos series (Fig. 11). Because so much of the near-earth exploration is under the Cosmos cover, we will consider this program in some detail.

THE COSMOS SERIES.—From 1962 on, most Soviet flights were simply named Cosmos and given a number. This broad label covered a great variety of scientific, manned precursor, and military uses (Fig. 12). It also was used to disguise certain failures which attained earth orbit but probably did not accomplish their full purpose. Thus, the Cosmos cover has been used to conceal failure, to avoid disclosing new programs or experiments, and to permit use of civilian satellites for military purposes. Even so, through study of repetitive orbital patterns, the kinds of debris associated with the flights, and the timing of these flights, it has been possible to group most of these payloads by mission.

Some of the small Cosmos payloads have been identified as fulfilling a variety of scientific missions equivalent to those of the Explorer series of NASA. Most satellites within this series orbit at 49 degrees inclination from Kapustin Yar. A few scientific Cosmos flights are launched from Plesetsk whenever studies

Figure 11. Region of Concentrated Soviet Space Activity.

of polar phenomena are undertaken. The bulk of the small Cosmos payloads launched, first from Kapustin Yar and now mostly from Plesetsk (at 71 or 82 degrees inclination), serve some military support function. No precise purpose can be defined from public sources.

The intermediate Cosmos payloads are sometimes put up eight at a time. These launches center around development of a space navigation system, probably in support of Soviet submarines. A satellite-based navigation system is acknowledged by the Soviets without mention of the individual satellites used. There is enough variety in the patterns of these flights that the suspicion arises that some flights serve as a secret data gathering function such as electronic ferreting for the military. The first launches were from

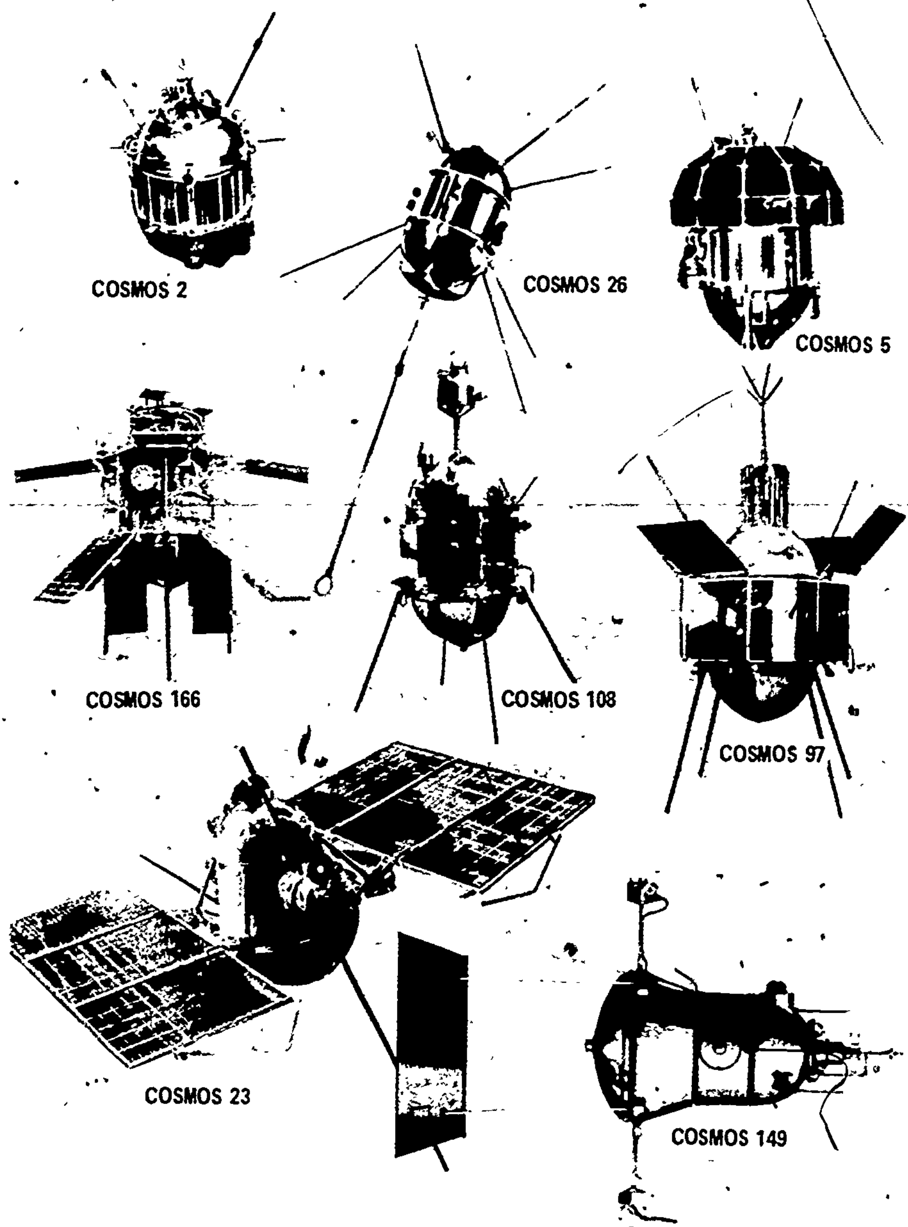

Figure 12. Cosmos Satellites.

Tyuratam, but the majority come from Plesetsk at 74 degrees inclination. New missions contained within this series are complicating the task of analysis.

The Military Observation Recoverable Cosmos: Several generations of satellites that could serve photographic and ferreting missions have been launched from Tyuratam and Plesetsk. All of these use the standard Series A vehicle, now with an improved upper stage. The external hardware closely resembles the series of manned Vostok craft. The latest shots have been known to stay up for 12 to 13 days. They often maneuver for greater accuracy in reaching selected targets of view and occasionally carry piggyback craft.

Precursor Craft and Failures within Cosmos: Each important new step in the manned program was preceded by an automatic Cosmos precursor before men were committed. This may stem from any of several reasons such as an attempt to hide the new program, a fear of failure, or a unique classification sys-

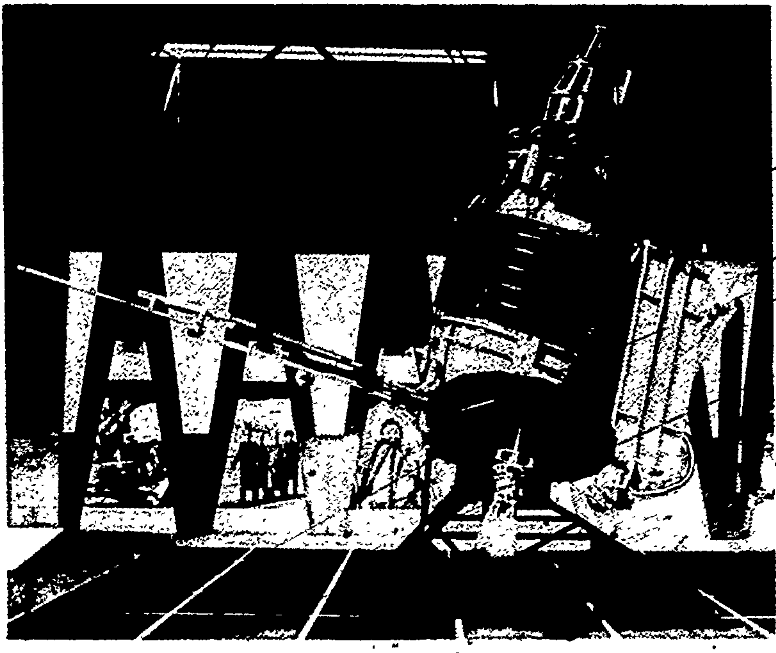

Figure 13. Molniya.

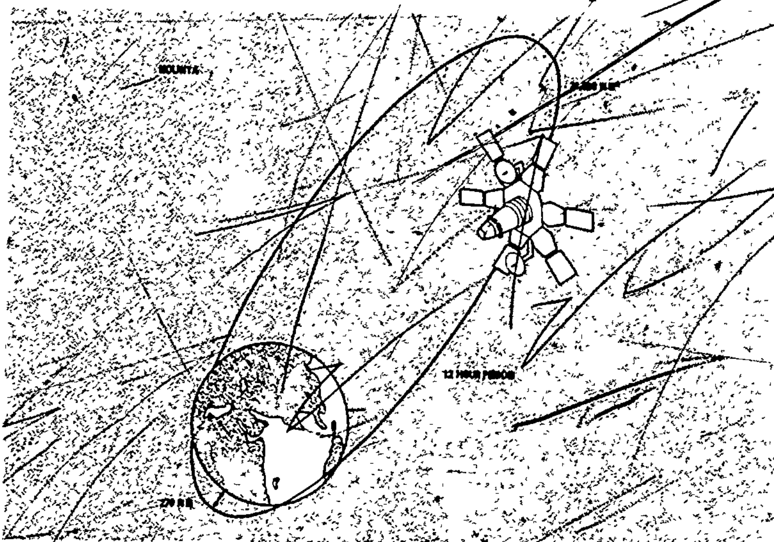

Figure 14. Molniya orbit.

tem. Whatever the reason, almost all unmanned tests of manned payloads are performed under the "Cosmos cover." Also, failures of deep space craft to leave earth orbit are given Cosmos names and glossed over without acknowledgement.

The Remaining Near-Earth Programs

There are only three exceptions to the "Cosmos cover" in the unmanned, near-earth category. These exceptions are the Molniya, Meteor, and Elektron payloads. Without question, the Molniya and Meteor series were developed under the Cosmos cover. As for the Elektron series, there is current speculation that its designation is a cover name for military observation flights.

THE MOLNIYA SERIES, 1965.—**Molniya** (lightning), Figure 13, is a communications satellite. There are at present two basic types, Molniya 1 and Molniya 2. To date, twenty-two Molniya 1 payloads have been orbited with Cosmos 21, 41, and 174, which appear to have been Molniya 1 failures. Four Molniya 2 have been orbited (25 Nov 1971, 19 May, 30 Sep, and 12 Dec 1972).

The primary characteristic of the Molniya payload is its eccentric orbit. (See Figure 14.) Both Molniya 1 and 2 fly an elliptical orbit that varies from an apogee (the point of an orbit most distant from the Earth) of around 24,000 miles to a perigee (the point of an orbit closest to Earth) of 300 to 400 miles, at an inclination of 64° to 65°. The US communications satellites are generally **geostationary** (remaining at a fixed point over the Equator). This is accomplished by orbiting the satellite at the same speed at which the earth rotates. The ground traces of the Molniya craft, however, are characterized by a slow, tight loop over the Northern Hemisphere, produced by its slow progress at apogee, and a wide, speedy loop into the Southern Hemisphere, produced as it speeds through its perigee (Fig. 15). The net effect is maximum exposure of Soviet territory, including areas out of reach of a geostationary satellite. The Molniya 2 spends 11 hours, 46 minutes within reach of the Soviet Union out of every 12-hour orbit. By keeping three Molniya satellites in orbit, the Soviet Union has complete and overlapping 24-hour communication coverage (Fig. 16).

THE METEOR SERIES, 1969.—In the spring of 1969, the Soviet weather satellites were given the name **Meteor** (Fig. 17), indicating that the program had shifted from an experimental status (under the Cosmos cover name) to an operational one. The Soviet Hydrometeorological Service, the counterpart of the US En-

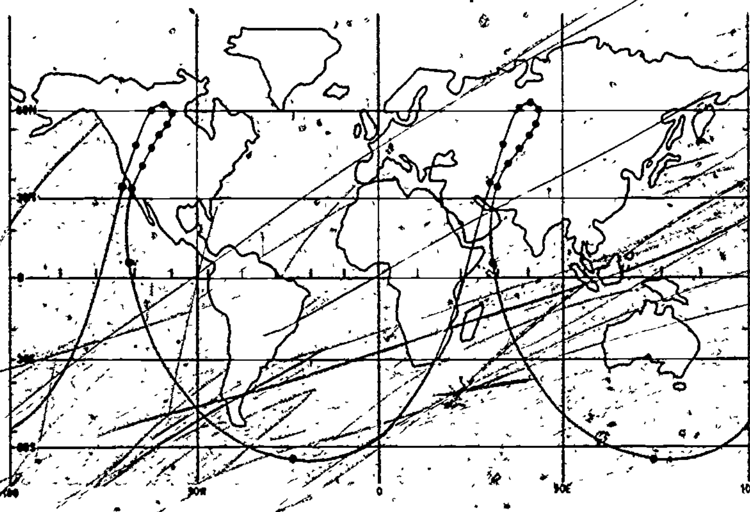

Figure 15. Molniya ground trace.

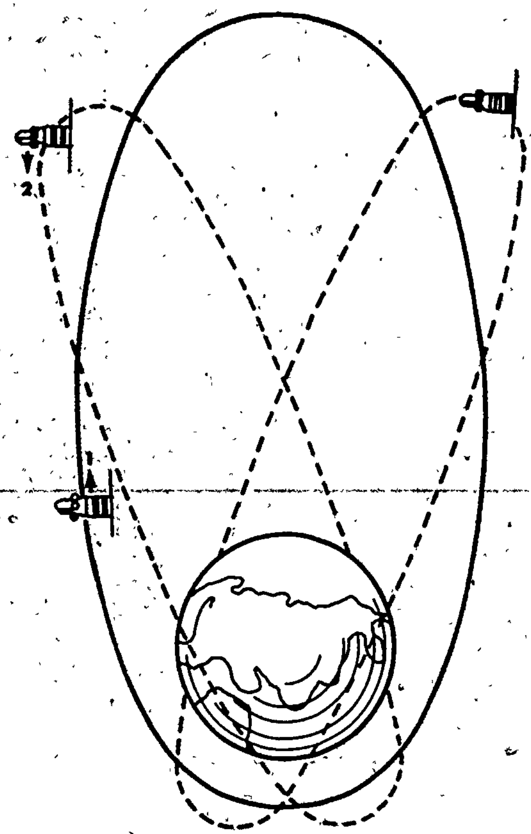

Figure 16. Organization of round-the-clock communications coverage. 1—beginning of radio communication session, and 2—end of session.

vironmental Science Services Administration (ESSA), assumed operational control over the weather satellites during this period. This followed the US pattern when NASA developed the original Tiros meteorological satellites before ESSA assumed operational responsibility.

THE ELEKTRON PAYLOADS, 1964.—In early 1964, the Soviets began another phase of their program. They launched two **Elektron**

Figure 17. Meteor: Meterological satellite.

payloads at one time. With a relatively low perigee, Elektron 1 orbited with an apogee of 4,400 miles; Elektron 2 orbited to 42,000 miles (Fig. 18). Such paired payloads could map radiation belts and provide **synoptic readings.*** The two were matched again six months later by Elektron 3 and 4. Considering their size and extensive arrays of solar cells, one cannot help but wonder whether they had other missions besides mapping radiation belts. For example, they were slightly reminiscent of the US Vela nuclear detection series.

*Provide readings over a broad area at once, such as relative intensity of the radiation belts. *Synoptic* photographs would be photographs showing all of the East Coast or Middle East, etc.

The Luna Program

After the success of the first generation of Luna payloads (Luna 1, 2, and 3), the Soviet Union decided to undertake a multipurpose Luna program. Such a program would include soft landings, lunar orbiters, lunar rovers, and the mechanical return of lunar samples. These projects were undertaken in the two successive generations of the lunar program.

THE SECOND GENERATION OF THE LUNA PROGRAM, 1963–1966.— Soviet space officials resumed lunar exploration with a soft landing program. The first flight in this program came in January

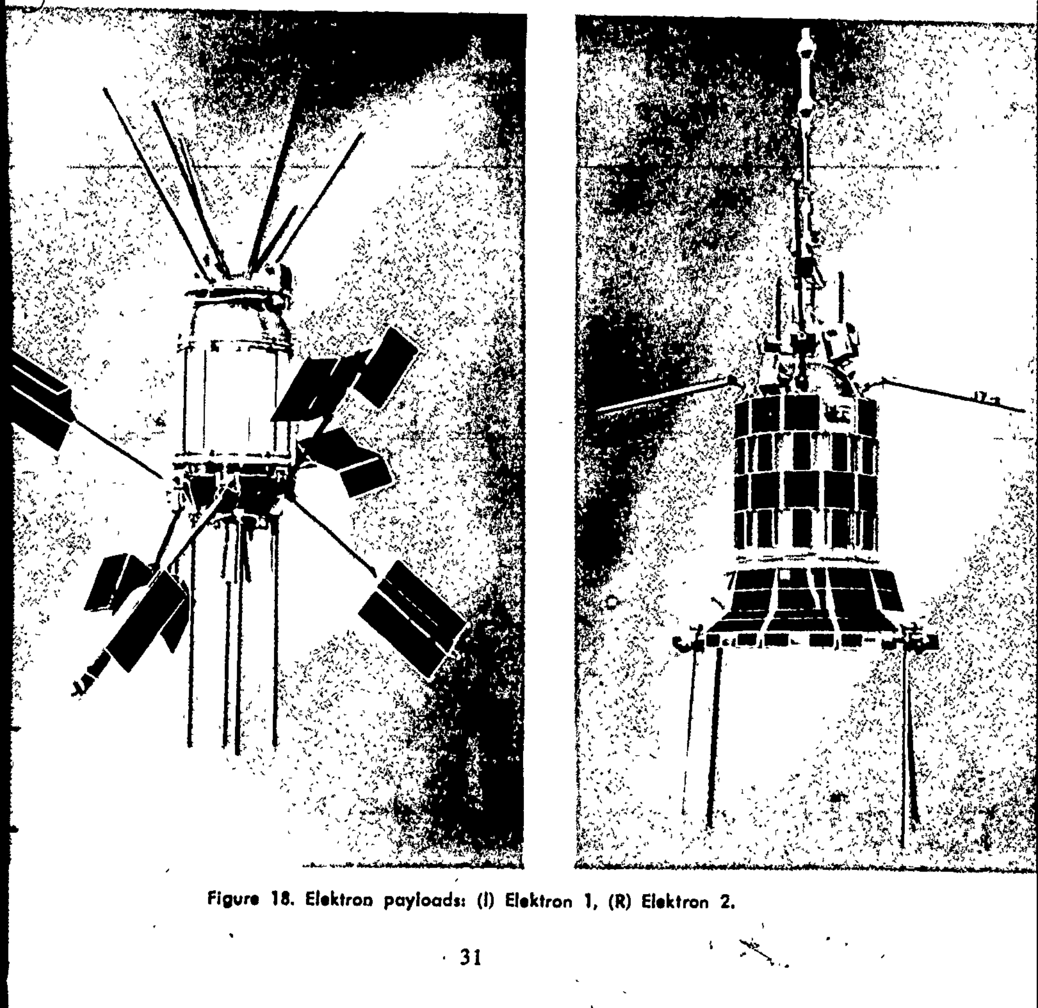

Figure 18. Elektron payloads: (l) Elektron 1, (R) Elektron 2.

1963. As in the American lunar programs, failure followed failure. The January shot and Cosmos 60 (cover name) failed to escape earth orbit, while Luna 4, 5, 6, 7, and 8 all missed or hard impacted on the moon.

Finally, in 1966, Luna 9 landed on the surface of the moon and returned 27 pictures in two earth days. Later, Luna 13 (Fig. 19) also returned pictures and took soil samples with a spring-driven arm that extended on command.

Lunar Orbiters. The Soviet space program developed a lunar orbiter capability earlier than one was developed in the United States program. Months before the first US Lunar Orbiter was launched, the Soviet Union followed Luna 9, the lander, with another launch on 31 March 1966. This became Luna 10 which orbited the moon (Fig. 20). Luna 10 made a variety of measurements, but there were no indications that it was intended to take pictures. Soon after Luna 10, Luna 11 was launched; it also made a wide variety of measurements. Finally, Luna 12 was placed in orbit around the moon and it returned pictures, some of which were released to the press. At the end of 1966, Cosmonaut **Vladimir Komarov** said that the program would be discontinued

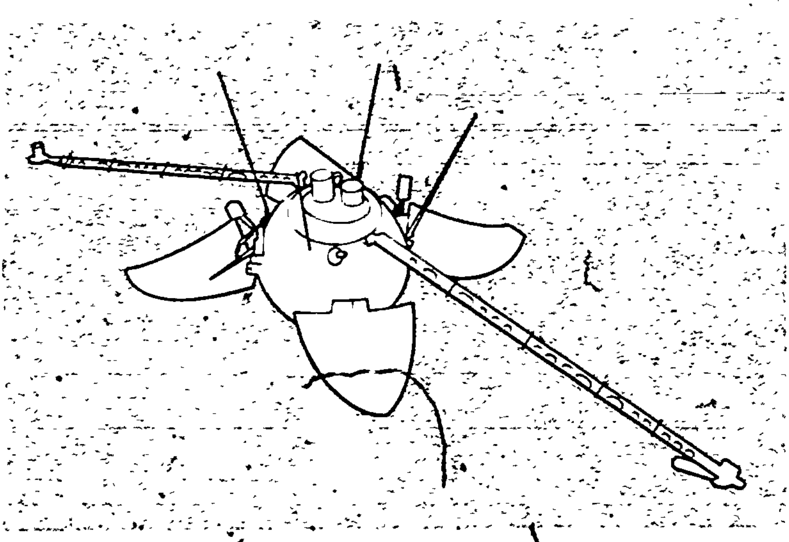

Figure 19. Luna 13: Lander.

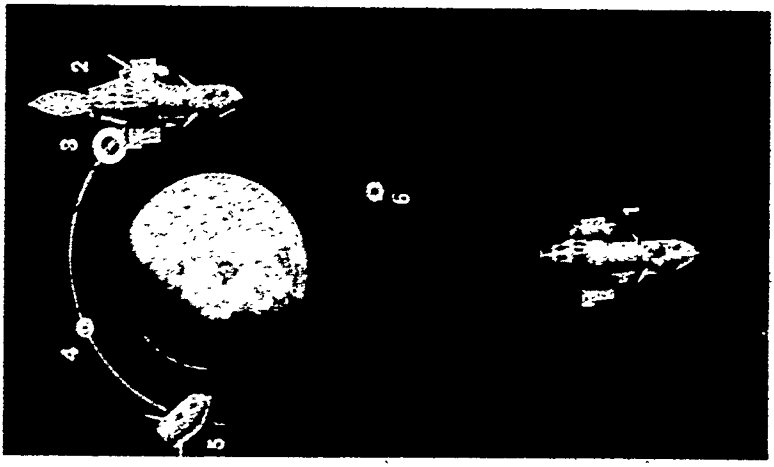

Figure 20. Diagram showing the injection of Luna-10 into luna orbit: 1—the probe is oriented along the moon's vertical. 2—the retro-rocket is fired. 3—the retro-rocket is cut off, and the lunar satellite detaches. 4—the lowest point of the lunar orbit. 5—the lunar satellite. 6—the highest point of the lunar orbit.

in favor of a program which would include an unmanned round trip flight to return to Earth with a lunar soil sample.

THE THIRD GENERATION OF THE LUNA PROGRAM, 1968.—The Soviets continued exploration of the moon, after 16 months of inactivity, with the launch of Luna 14 on 7 April 1968. This continuation has three major phases. orbiters, return landers, and lunar rovers.

So far, three third generation lunar orbiters have been launched. These were Luna 14, 15, and 19. The lunar orbiters have four primary missions. study of the lunar gravitational field and the relation between masses of the earth and moon, measurement of the streams of charged particles emitted by the sun, study of the propagation and stability of radio signals transmitted between earth and the moon, and collection of more data on the moon's motion in space.

The first of the return landers was Luna 16 (Fig. 21). It was followed by Luna 18, which crashed, and Luna 20. The function of the lunar landers was to land, drill out a core sample of lunar rock and soil, and then return to earth (Fig. 22). The samples contained only about three ounces of material, in contrast to the several pounds of rocks and soil samples returned by the US Apollo missions.

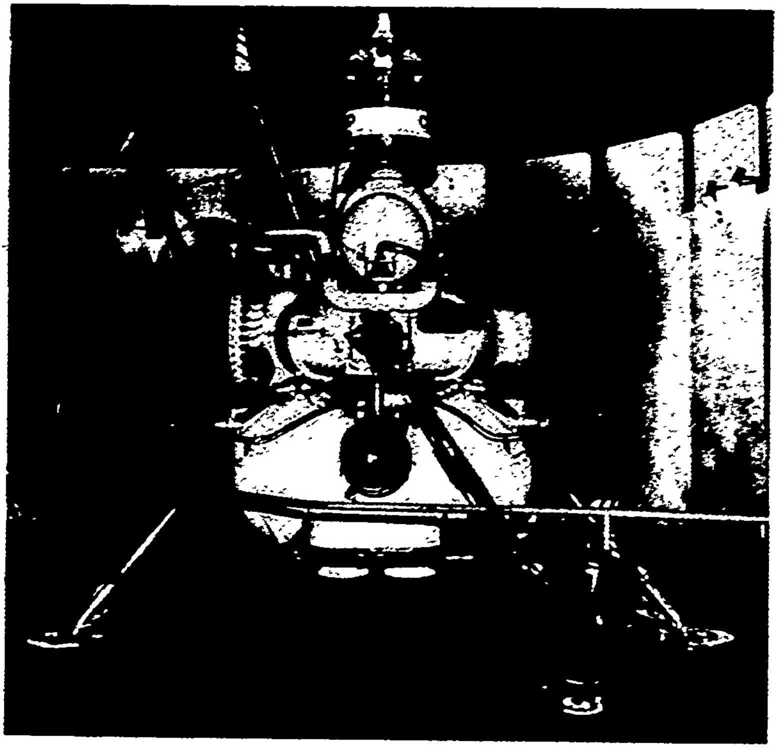

Figure 21. Luna 16: Lunar lander-return.

The final program goal was the lunar rover. On 17 November 1970, Luna 17 deposited **Lunokhod** (Fig. 23), in the moon's Sea of Rains. During Lunokhod's 10 months of roving, before its **isotopic fuel** used for heating purposes during sub-zero lunar nights was depleted, it traveled a total of 24,500 feet. During its travels it transmitted more than 20,000 photographs and more than 200 panoramas of the lunar surface, performed physical-mechanical analyses of lunar soil at approximately 500 separate locations and chemical analyses at 250 different locations. When its heat source was near exhaustion, it was parked on flat terrain where its French-built **laser reflector** was directed toward the earth for continued experimentation.

The Planetary Program

The final area of unmanned activity is the planetary program. This program has suffered from a distinct backseat position in relation to other programs. Perhaps this will change as the manned program eventually develops in this area of exploration.

The planetary program consists of interplanetary probes. This series has two major characteristics. First is the weight lift capacity of the Soviet launch vehicles, exhibited by the unmatched 2,439 pounds of **Venera** 4. Overall, the Soviet planetary program has been very ambitious, committing about 11 times the weight of payloads to such missions as the United States. The second

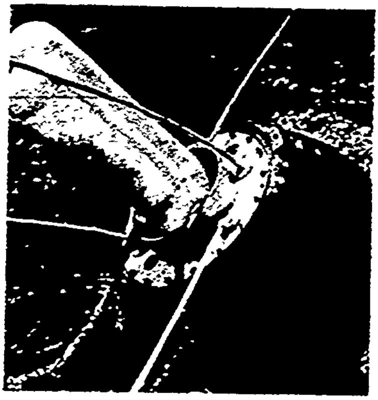

Figure 22. Luna 16: Reentry capsule.

characteristic is the consistent failures of support systems. After the failure of Venera 3, the Russians had extended their record to 17 consecutive failures in 17 attempts. To date, the Soviet Mars missions have returned no surface data, (Mars 2 and 3 are operating in orbit), and only Veneras 7 and 8 were successful in surviving their landings on Venus (Fig. 24, 25). The only attention-catching event in the program came on October 1962, during the Cuban Crisis, when a launch exploded into a cloud of debris. As the cloud of debris approached Alaska, the BMEWS radar defense picked up what appeared to be a mass ICBM attack.

THE MANNED SPACE PROGRAM

The key to the Soviet program has been the manned space program. True to the spirit of Tsiolkovsky's dream, it has been man himself who has penetrated beyond the atmosphere to explore space. The exploration has gone through three evolving programs: **Vostok, Voskhod,** and **Soyuz.**

The Vostok Program, 1960–1963

With the experience gained in the Laika flight of 1957 and the standard launch vehicle plus the upper stage used for the Luna flights, Soviet scientists and engineers had available several of the essentials for manned flights. The Soviet Union soon announced the beginning of precursor (unmanned test flights) with the launch of Sputnik 4. It carried an instrumented dummy in its passenger cabin. After four days in orbit, the ship assumed reentry position. Clearly something went wrong; the cabin separated and ascended into a higher orbit, (indicative of the wrong attitude at the time of retrofire) in which it lingered for five years until its orbit decayed.

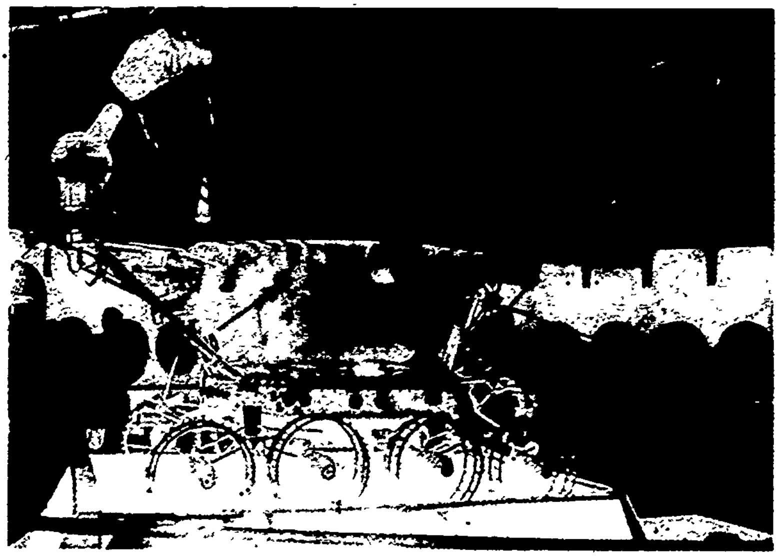

Figure 23. Lunokhod: Lunar rover.

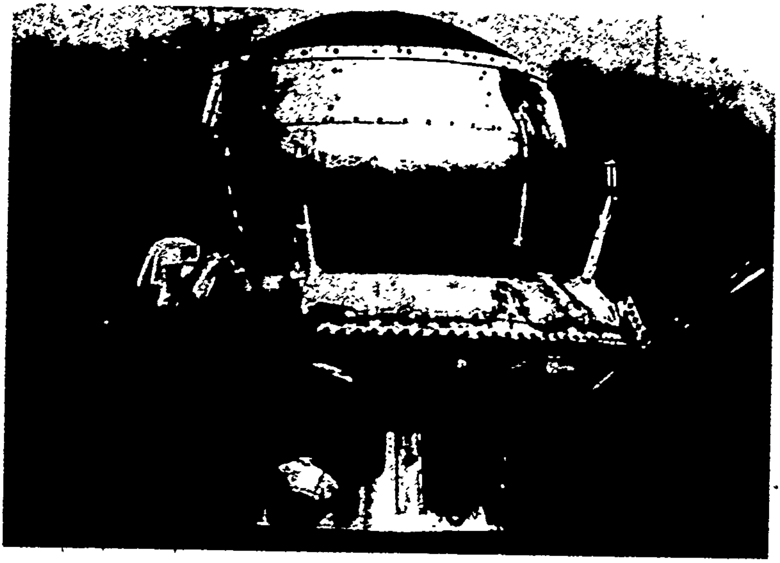

Figure 24. Mars Lander.

Figure 25. Venus 7: Entry capsule.

The test was repeated in August 1960, this time with two dogs on board, **Strelka** and **Belka** (Fig. 26). These were the first living creatures successfully recovered from orbit. The third flight was announced in December, when two more dogs were put up. Again something went wrong with the recovery phase, and the Russians announced that the two dogs **Pchelka** and **Mushka** were lost as the ship burned on reentry.

In quick succession on 9 and 25 March 1961, the Russians ran two more dog flights, each with a single dog, **Chernushka** and **Zvezdochka**, each for a single orbit of the Earth. These were successful and were **analogs** (exact duplicates) of the first manned flight to follow on 12 April 1961.

MAN IN SPACE.—After one orbit in Vostok 1 (12 April 1961), Yuri Gagarin (Figs. 27-29) earned his place in history as the first man in space and the first man to orbit the earth. The effect was electrifying on world opinion in much the same way that Sputnik had seized such complete attention.

Before John Glenn went up in 1962 (to become the first American in orbit), the Russians in the summer of 1961 had also sent up **Gehrman S. Titov** for a total of 17 orbits. Thus, with Vostok 2 and John Glenn's Mercury craft (Friendship 7) safely on the ground, the Russians were far in the lead. They had completed

Figure 26. Belka and Strelka—the first animal cosmonauts to come back from space.

Figure 27. Last briefing before take-off (Gagarin).

Figure 28. The first manned spaceship is launched (Gagarin).

Figure 29. Yuri Gagarin—first man in space.

an impressive 118 orbits (100 unmanned, 18 manned) of successfully controlled flight with the Vostok craft as compared to 6 (3 unmanned, 3 manned) orbits by the Mercury craft.

COMPARISON OF VOSTOK TO MERCURY.—During the first phase of manned flight, the Russians had several advantages because of their greater lifting capacity. The US Mercury capsule was limited to 3,000 pounds and was designed for only three orbits. The internal atmosphere was five pounds per square inch (P. S. I.) pure oxygen. The Vostok craft weighed over 10,000 pounds, and, from the first, carried consumables for a 10-to-14-day stay in orbit, so that if the retrorocket failed to fire, natural decay resulting from the low orbit would give the cosmonaut some chance of survival. The Soviet craft's internal atmosphere was a normal mix of gases at sea-level pressure (14.7 psi).

The Vostok spacecraft had other advantages because of its greater size. The cabin was fairly roomy with its eight-foot spherical interior. The ships from the beginning of the dog flights carried live television systems so that observers on earth could view conditions during flight, and pictures could be fed into the broadcast network for the public to view.

VOSTOK PAIRED FLIGHTS.—The Soviet Union on 11 and 12 August 1962 moved ahead to a more ambitious phase of the Vostok program. One day apart, it launched Vostok 3 and 4, so that two men were in orbit at the same time. They stayed up for 4 and 3 days, respectively. The second launch was timed so that it was a direct ascent, near rendezvous with the ship already in orbit. At the closest point, they were only four miles apart.

On 14 and 16 July 1963, Soviet space authorities launched Vostok 5 and 6 two days apart; Vostok 6 carried the first woman into space. These ships were in orbit for 5 and 3 days, respectively. It is interesting that the Russians had enough confidence in their ship by this time that they would send up a relatively untrained woman (a former factory worker) as opposed to a highly trained test pilot. With her 48 orbits **Valentina Tereshkova** (Fig. 30), gained more space time than all six Mercury astronauts combined.

There was discussion as to whether the Russians intended a closer rendezvous on the 1963 mission. But the data shows conclusively that the Russians did not intend to complete a rendezvous. Nevertheless, the Russians claimed that the vehicles passed within three miles of each other.

Polyot Payloads, 1963–1964

The most obvious deficiency of the Vostok series was the inability of the craft to maneuver into a rendezvous. Consequently, it was of little surprise when the **Polyot** (flight) payloads appeared.

In the fall of 1963, the first Polyot payload was placed in orbit. The advertised purpose was to add a maneuver capability which had been so evidently lacking in the Vostok manned series, and which would be necessary for rendezvous and docking in sustained operations. Many months passed before Polyot 2 came in 1964. There were some advertised changes in apogee and perigee for both spacecraft, but the amount of plane change (varying inclination) was not made clear, and probably was not impressive.

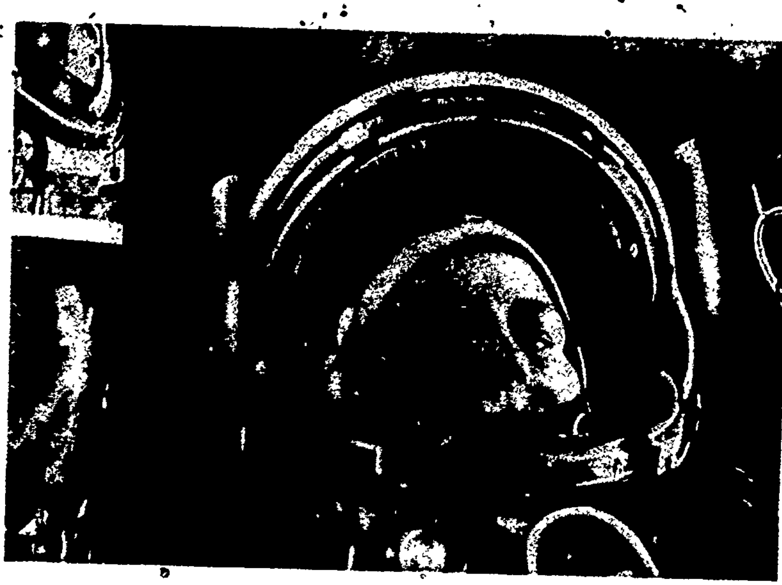

Figure 30. Valentina Tereshkova—first woman in space.

Renewed Manned Flights with Voskhod, 1964–1965

Following the conclusion of the Polyot series, precursor flights were resumed under the Cosmos cover. The Russians made a flight on 6 October 1964, called Cosmos 47. It stayed up for only one day, and its low perigee was typical of manned flights and their precursors. A week later following this success, the Russians launched Voskhod 1 (Fig. 31). There was nothing to suggest that this ship was anything more than a Vostok with modifications, rather than a whole new generation craft. The eight-foot-diameter ball cabin of the earlier ship would easily accommodate three men side by side, as Soviet interior pictures later revealed. The most conclusive hint, however, is in the name itself. Voskhod, in its archaic sense, means the same thing as Vostok, ie, east.

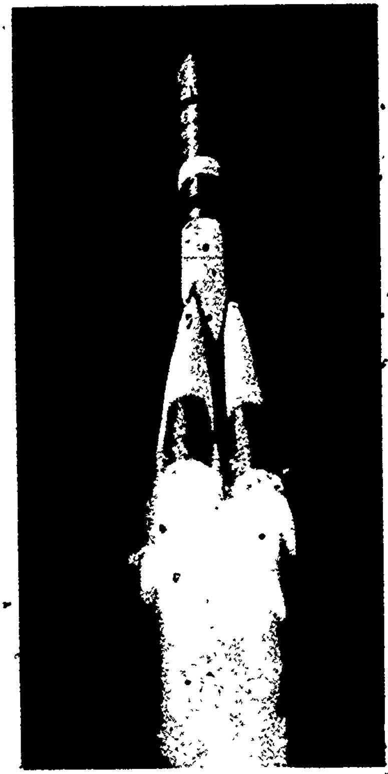

Figure 31. Voskhod launch vehicle.

The Vokshod 1 flight stayed up one day, just like its precursor. It carried three men—a senior pilot, **Komarov,** an aeromedical doctor, **Yegorov** and, for the first time in the Soviet program, a civilian scientist, **Feoktistov.** The flight was interesting because, for the first time, a physician could make detailed studies of human beings in a weightless condition in person.

Despite the vast number of similarities between Voskhod and Vostok flights, there were two important differences. Extensive use of the ejection seat and parachutes during recovery was typical of the Vostok series. In Voskhod, the Russians claimed an added capability. The vehicle would make a soft landing with the crew on board rather than have the crew parachute before the capsule landed. It is also interesting to note that the Voskhod crew did not wear pressure suits. Instead, they wore knitted coveralls of comfortable design and, as before, were in earth-like atmosphere. Though both of these innovations added greatly to the comfort of the cosmonauts, their desirability was destined to be questioned by those who knew **Komarov, Dobrovolskiy, Volkov,** and **Patsayev,** cosmonauts who were to die because they did not have ejection seats or pressurized suits. This may well have been the point marking the end of Russia's initial advantage in booster capability. After this, the Soviet Union was forced to make weight trade-offs to continue its competition with the US space program.

In preparing for Voskhod 2, the Russians launched Cosmos 57 as an analog to manned flight. It started out routinely, but, shortly, normal tracking sensors discovered a new cloud of debris along the orbit that the Cosmos had traveled. As a result, no manned flight followed immediately. Apparently, after a month of investigation, the Russians were satisfied that a manned flight could be made safely, and they sent up Voskhod 2. This time, there were only two men aboard. The weight of the absent cosmonaut was traded off against a collapsible airlock. By this means, **Aleksei Leonov** (Fig. 32) became the first man to accomplish **extravehicular activity** (EVA). He emerged from the capsule through the airlock and, for about 20 minutes, was exposed to the vacuum of space, including 10 minutes of floating at the end of a safety line. On this flight, the Russians resumed the use of pressure suits, and command pilot **Belyayev** was equipped so that he could go after Leonov if anything went wrong. This was the last of the Voskhod flights. Since it was only an extension of Vostok technology, a long pause followed as the Russians worked to develop a new generation of spacecraft.

Proton Payloads, 1965–1969

Again, in the interim between manned projects, another short-term project appeared. Throughout Voskhod, weight tradeoffs had been required. A launch vehicle with greater lift capacity than the "A" series booster was now needed.

In response, the Russians announced the **Proton** flights. These were four duplicate cosmic ray experiments. The Russians were doing something worthwhile, but almost to a point of apparent redundancy. The Proton payload (Fig. 33) with its huge blocks of paraffin, metal, and special sensors, was able to measure energies to a level of 100 trillion electron volts. These were some of the highest energy fluxes ever detected by human instruments. The real mission of the series, however, was not cosmic ray measurement. Proton payloads were used to test the Series D launch vehicle, allowing it to be rated to carry loads far in excess of the Series A. This justified the redundancy and made the series a success.

Figure 32. Alexi Leonov, the first man to walk into space.

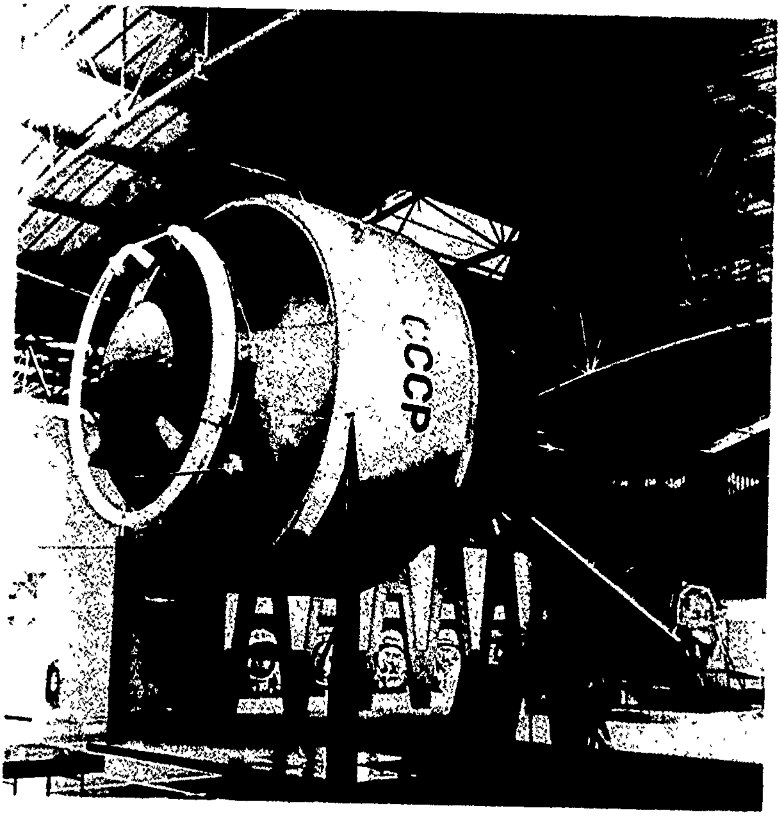

Figure 33. Proton 4—the world's largest automatic orbital laboratory.

Return to Manned Spaceflight with Soyuz

With the US sights set on a unilateral goal of a manned moon landing, the Soviet Union embarked on what appears to have been a dual program of a manned moon landing and an orbital space station using Soyuz spacecraft (Fig. 34). As time passed, the American lunar program lead increased, and the Soviets appeared further and further behind. To many, this was a sign of weakness in the Soviet program until one stopped and realized two important facts. First, the Soviets have the capability of placing a man on the Moon, our advantage is that we can carry enough propellant to bring him back. Should the D-1 vehicle be man-

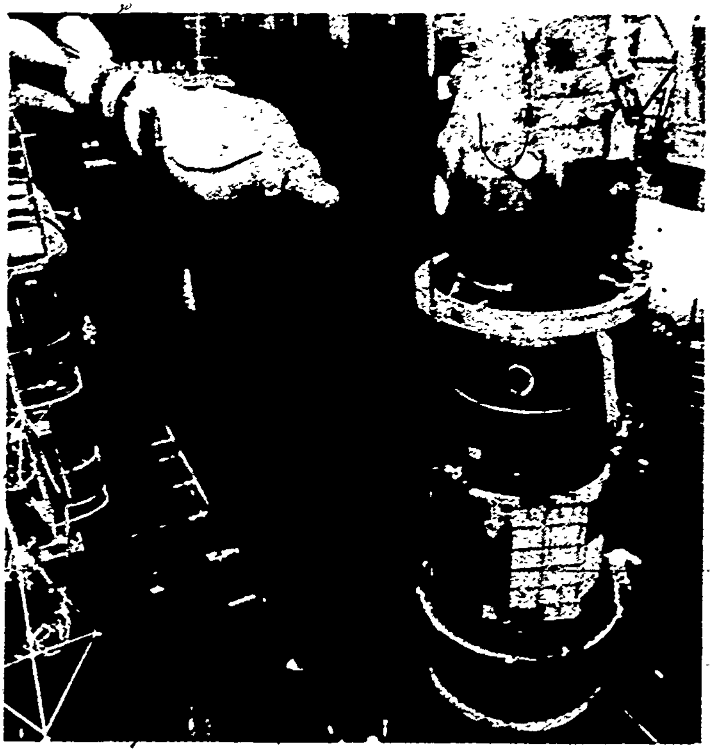

Figure 34. Soyuz Payload in foreground, Soyuz launch vehicle with payload attached in background.

rated, this problem will be overcome. Second, outside of lunar exploration, the continuation of our manned space program will probably require an orbiting space station. On this count, the Soviet Union is not behind. If the same vehicles are used for both the orbiting space station and the manned lunar program, it would be consistent with the carefully planned economy characteristic of the Soviet program. This is the same economy that has kept the Soviets even with, or ahead of, the United States in most other space ventures.

SOYUZ 1—THE DEATH OF KOMAROV.—The Soviet program and safety record had been unblemished until the Soyuz program. The first Soviet death was recorded when Col Vladimir Komarov (Fig 35), after completing a successful test flight in Soyuz 1, had parachute difficulties and died when the absence of an ejection seat left him trapped in the crippled craft.

The flight of Soyuz 2 and 3 was, fortunately, much less eventful. Soyuz 2 was launched pilotless and Cosmonaut **Beregovoi** took Soyuz 3 aloft for rendezvous maneuvers. He rendezvoused twice with the Soyuz 2 craft before making a safe reentry.

The next feat of the Soyuz was a space transfer of cosmonauts from one craft to the other (Fig. 36). To accomplish this mission, Soyuz 4 was sent aloft with only the ship's commander, **Shatalov**, and was followed by Soyuz 5 carrying cosmonauts **Volynov, Yeliseyev,** and **Khrunov.** After inflight rendezvous and docking, Yeliseyev and Khrunov (Fig. 37) transferred to the Soyuz 4 craft to perform a few selected experiments, and then descended to earth on board Soyuz 4. This mission was the world's first space docking and the world's first inflight crew transfer.

Figure 35. Col Vladimir Komarov.

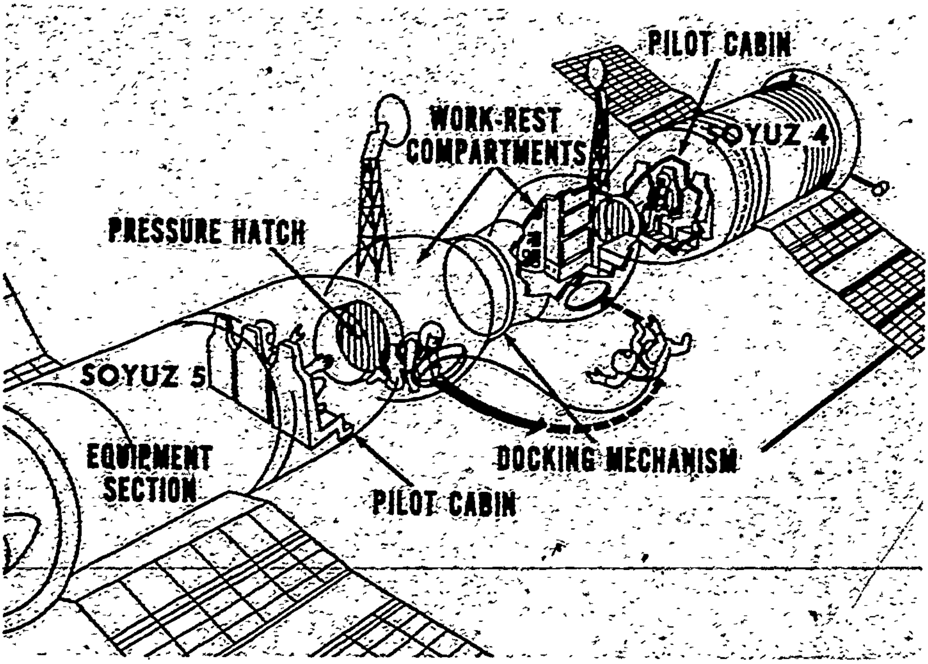

Figure 36. Diagram of Soyuz Crew transfer.

Following the success of Soyuz 4 and 5, Soyuz 6, 7, and 8 were launched. At various intervals, these three crews (Fig. 38) flew in tight formation, but the mission appeared a failure because no docking maneuvers were performed. They did, however, perform the first outer space welding operation, proving that such operations were possible in a weightless vacuum.

Confident of the ability of the Soyuz craft, the Russians set out to surpass the space endurance record held by American astronauts Borman and Lovell (Gemini 7, 14 days). Soyuz 9 was launched 1 June 1970 and remained in orbit for a record 18 days.

Finally, the Soviets were ready to begin the real mission of the Soyuz series: rendezvous and docking with an orbiting space station, the first step to the moon and planets (Fig. 39). First, Salyut 1, the space station (Figs. 40 and 41), was put in orbit. Second, Soyuz 10 was launched to test rendezvous maneuvers.

Third, Soyuz 11 completed rendezvous and docking, and the crew transferred to Salyut 1 where they performed the first scientific experiments in a manned orbiting space station. After completing their work, the cosmonauts reentered the Soyuz 11 craft and prepared for their long journey home. The Soviets again broke the endurance record (24 days). As they began reentry operations, there was a sudden depressurization of the spacecraft and cosmonauts Dobrovolskiy, Volkov, and Patsayev, trapped without pressure suits, were killed instantly. On this tragic note, the Soyuz operations were suspended, and the program was tucked beneath the Cosmos cover for extensive unmanned testing. Since then, the Soviets have announced their intentions to continue with manned flight, but, through FY 1972, they have not resumed.

Figure 37. Soyuz Cosmonaut Khrunov who performed EVA transfer from Soyuz 5 to Soyuz 4.

Figure 38. The crews of Soyuz 6, 7, and 8. Standing (l-r): Victor Gorbatko, Anatoly Filipchenko, Vladislav Volkov. Sitting (l-r) Valery Kubasov, Georgy Shonin, Valdimir Shatalov, and Alexey Yeliseyev.

Zond Flights, 1961

In the same manner that unmanned activities progressed from near-earth to lunar to planetary, the Zond series hints that the manned program is designed to do the same (Fig. 42). However, in its decade of existence, Zond has not advanced beyond the precursor level.

Although Western observers had expected Russians to be the first to circle the Moon, various troubles delayed the program. Zond 5 (Fig. 43), 6, 7, and 8 have all been identified as manned precursors and have returned to Earth after flying around the Moon. These ships seem to be an adaptation of the Soyuz without its work compartment, and they are launched by the D-1-e vehicle. A lifting reentry used for some passages through the atmosphere has enabled them to cut the G-load and the intensity, if not the duration, of the heating. Some of these flights have carried biological experiments, and some have returned high quality pictures, including color pictures of the Moon and Earth. The pressure to extend the Zond program to manned flight has been eased by the greater Apollo successes.

SOVIET MILITARY SPACE ACTIVITIES

The final area of the Soviet space program is military space activities. Although many "civilian" projects have had strong military overtones (Cosmos, Elektron), there has also been a distinctive military program that has shown consistent development. As pointed out in Chapter 1, the series A, B, C, and F launch vehicles are converted military ICBMs (Fig. 44).

The Soviet Union claims each individual space flight to be scientific in character, and, in the early years, many charges of aggressive military intent were made against the United States

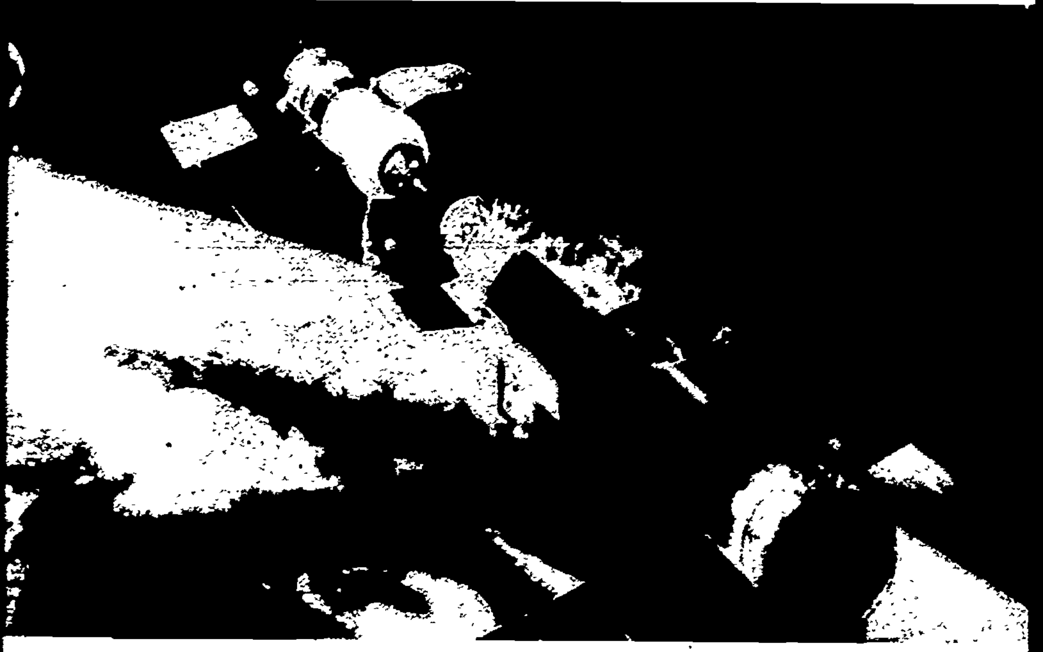

Figure 39. Artist's conception of Soyuz/Salyut docking in space.

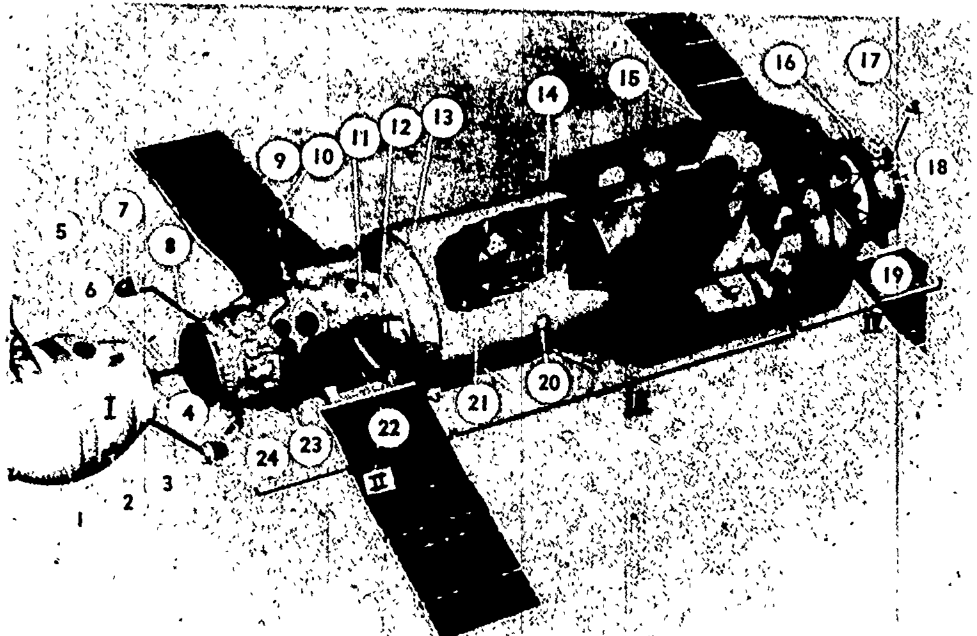

Figure 40. Diagram of Salyut.

Legend

I. Space ship SOYUZ.
II. Transfer compartment.
III. Working compartment.
IV. Equipment compartment.

1. Orbital compartment of the SOYUZ space ship.
2. Poits of the orbital compartment.
3. Search scanning system antenna (ship).
4. Television camera.
5. Guidance system antenna (ship).
6. Ship docking mechanism pin.
7. Search scanning antenna system (station).
8. Docking apparatus receiving cone (station).
9. Solar battery panels.
10. Guidance system antenna (station).
11. ORION astronomical systems.
12. Access hatch between the transfer and working compartments
13. Light indices.
14. Working compartment scientific equipment.
15. Life-support equipment.
16. Orientation system microengines.
17. Search scanning system antenna (station).
18. Internal scanning television camera.
19. Systems on the equipment compartment.
20. Working compartment ports.
21. Cosmonaut couch at the station's central panel.
22. Transfer compartment ports.
23. Spherical tanks with pressurized gases.
24. Orientation sensor.

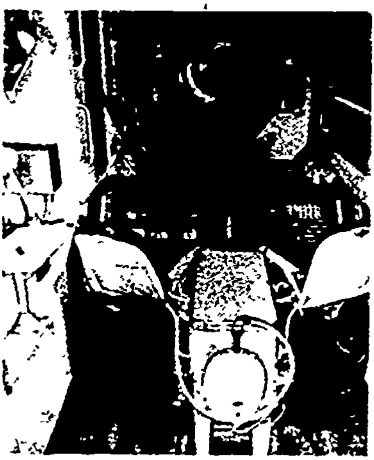

Figure 41. Interior of Salyut.

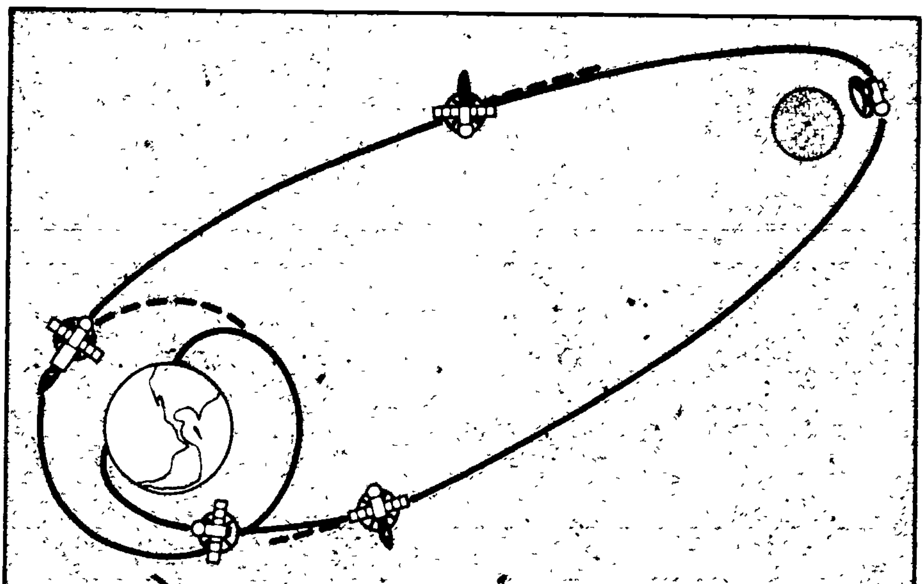

Figure 42. Luna Zond Profile.

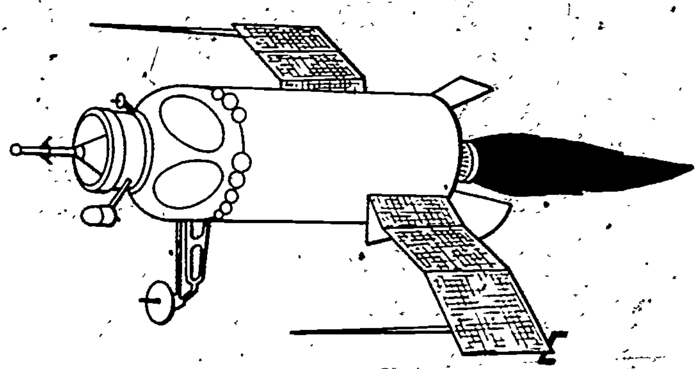

Figure 43. Zond 5.

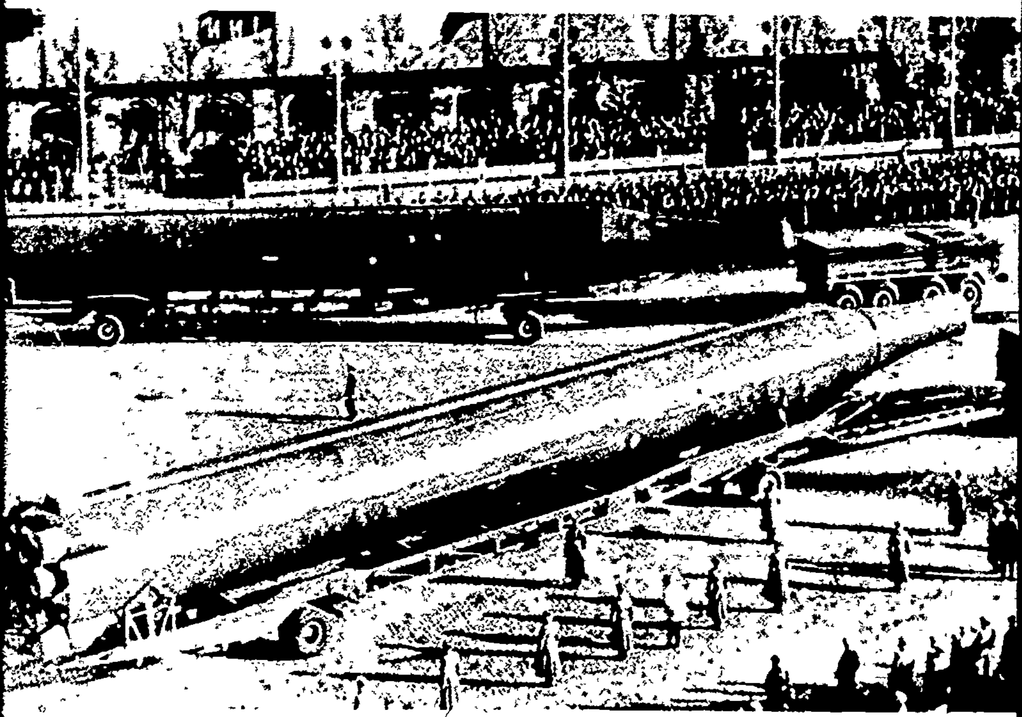

Figure 44. USSR ICBM.

space program. As Soviet military space capabilities have grown in quantity, variety, and operational effectiveness, such charges against the United States have largely been muted. A certain accommodation between the nations has been tacitly developed in this regard.

Although no space flights can be designated in the categories of weather reporting or communications, it would be strange if there were not Soviet military customers for services provided by the Meteor and Molniya satellites. Command and control systems are very important in an age of thermonuclear weapons, therefore, it is safe to assume that some spacecraft supplement such systems and that these are hidden within the total complex of programs in the interest of back-up support and security.

Satellite systems in support of navigation, traffic control, geodesy, and mapping either are known to exist or are under discussion in Soviet literature as important emerging uses. These are not specifically labeled as military, nor are individual flights admitted when they occur. Yet, a satellite navigation system is almost certainly an operational military support system. Traffic control may be coming later. Geodesy undoubtedly has been undertaken to develop the data base for missile targeting, and mapping probably has been done in some instances.

Military observation satellites, discussed previously in the Cosmos program, are the largest single elements in Soviet space operations. Photographic recoverable missions fly throughout much of the year with virtually continuous coverage. Infrared and nuclear detection missions may be hidden within purportedly scientific programs. A variety of electronic ferreting missions almost certainly are flown as a part of the large number of repetitive non-recoverable flights that do not have specified purposes.

Apparently, fractional orbit bombardment satellites (FOBS) (Fig. 45) as a system are operational, and some of the SS-9 silos may carry FOBS payloads (F-1-r) in place of ICBM warheads. After an intensive flight development program, the few flights that now continue probably represent troop training.

There is no indication that any FOBS has carried an actual nuclear warhead during the development or training period. Nor has any such dummy warhead crossed the United States. FOBS

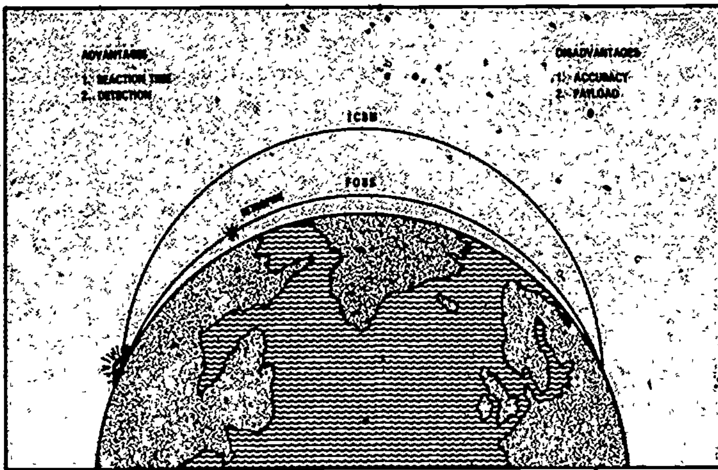

Figure 45. FOBS.

tests are retro-fired over the Soviet Union just short of one orbit, which avoids passage over the United States.

Although most US analysts doubt the cost-effectiveness of FOBS, undoubtedly, their presence in the Soviet inventory complicates US planning. They can come the long way around or fly by a direct route with a depressed trajectory, tending to reduce early warning. But new US sensors may decrease this advantage. Also, FOBS payloads are reduced in weight compared to the SS-9 as an ICBM, and accuracy could be sacrificed.

The same F-class launch vehicle, which puts up FOBS, also is used to launch satellites capable of making a close pass near other (uncooperative) satellites. Such passes are presumably for purposes of inspection, and potentially for the destruction of the target satellite. Several flight modes have been used (Fig. 46), with most of the inspector satellites being destroyed after the pass.

The potential threat of satellites such as these is to deny the use of space to other nations. There is no sign at this point that such a threat will soon exist.

Some other maneuverable payloads put up by the F-class launch vehicle probably serve other military pruposes that have not yet been defined by Western analysts. The uses may go beyond the kind of military support flights of a passive nature which make up all US military space flights and the bulk of Soviet military space flights as well. It would be premature to leap to alarming conclusions about these obscure flights, but, with their indirect weapons associations, they bear special watching if more occur. It would be entirely unwarranted to conclude that there is already a violation of the treaty that bans the orbiting of weapons of mass destruction.

CONCLUSION

Most Americans are amazed after they have discovered the total complexity of the Soviet space program. Far from cheap publicity shots and selected military missions, the Soviet space program parallels the US program in sequence, mission, and accomplishment, with the one exception of the Apollo-Soyuz split in mission direction.

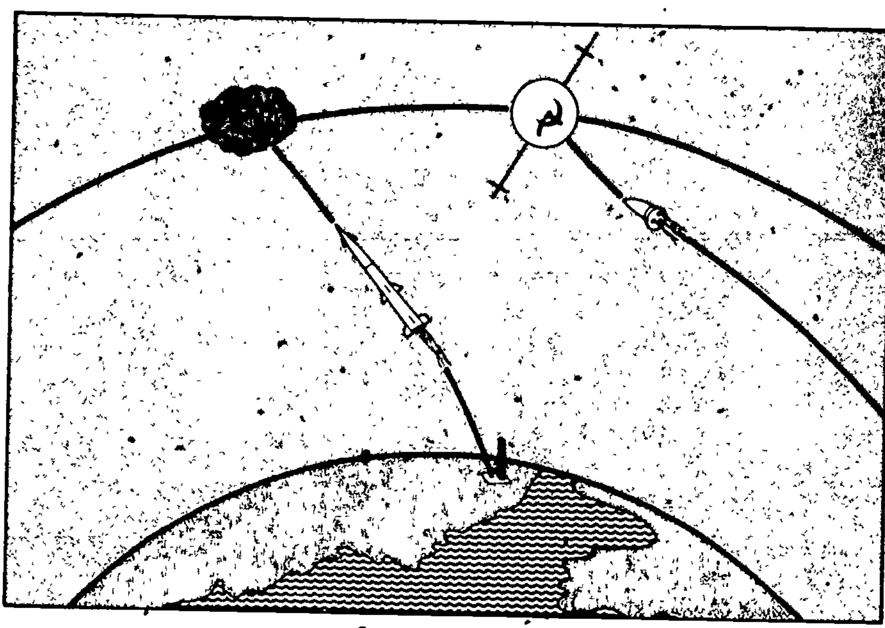

Figure 46. Co-orbit Satellite Interception Techniques.

Beyond a competitive comparison, a few additional facts are of interest. First, we have never lost an astronaut in reentry. Second, the Soviets have never lost a cosmonaut in take-off. Third, we have both been highly redundant by pursuing separate programs directed toward the same mission goals. Perhaps the future program will be a cooperative US/USSR space effort that is safer, cheaper, and more effective than the individual programs of the past.

WORDS, PHRASES, AND NAMES TO REMEMBER

International Geophysical Year
Laika (LIGH-kuh)
natural decay
Luniks
artificial planetoid
Cosmos
Cosmos cover
Molniya (MOHL-nee-yuh)
geostationary
Meteor
Elektron
synoptic readings
Vladimir Komarov (vluh-DEE-mir kah-mah-ROFF)
Lunokhod (loo-nah-HOTE)
isotopic fuel
laser reflector
Venera (vi-NYEH-ruh)
Vostok (vah-STAWK)
Voskhod (vahss-HOTE)
Soyuz (sah-YOOS)
Strelka (STRELL-kuh)
Belka (BYELL-kuh)
Pchelka (PCHELL-kuh)
Mushka (MOOSH-kuh)
Chernushka (TCHOR-noosh-kuh)
Zvezdochka (ZVYOZ-dutch-kuh)
analogs
Gehrman S. Titov (GEHR-mun S. tee-TOFF)
Valentina Tereshkova (vuh-lin-TEE-nuh ti-rish-KO-vuh)

Polyot (pahl-YOTE)
Komarov (Kah-mah-ROFF)
Yegorov (YEH-gah-ruff)
Feoktistov (feh-YOHK-ti-stuff)
Dobrovolskiy (duh-brah-VAWL-skee)
Volkov (VAWL-kuff)
Patsayev (putt-SAH-yeff)
Aleksei Leonov (ah-lek-SAY leh-YOH-nuff)
extravehicular activity
Belyayev (byell-YAH-yeff)
Proton
Beregovoi (bi-ri-gah-VOY)
Shatalov (shah-TAH-luff)
Volynov (vah-LEE-nuff)
Yeliseyev (yell-yee-SAY-eff)
Khrunov (hroo-NOFF)
Salyut (sahl-YOOT)
Zond (ZAWNT)

QUESTIONS

1. **List 10 important "firsts-in-space" scored by the Soviet Union.**
2. **The Cosmos series of Soviet satellites has yielded over 500 satellite launchings. What are the general goals of Cosmos satellites?**
3. **Name the three near earth programs that are not under the "Cosmos cover."**
4. **Outline the development of the Luna program. Be sure to include launches, missions, and accomplishments.**
5. **What are the names of the Soviet Union's manned space flight programs to date?**
6. **List five cosmonauts and identify the program(s) in which they participated.**
7. **What is "Zond?"**
8. **List five mission goals of the Soviet military space program?**
9. **What is FOBS?**

THINGS TO DO

1. Using styrofoam, wire, cardboard, and any other materials available attempt to fashion models of Soviet satellites and space craft. Use them in class discussions or simply to add to the atmosphere of the classroom.

2. Since there are far too many Cosmos launches for this text to deal with individual flights, make a chart of the general goals listed in the chapter. Under each goal, place the number of all Cosmos launches you feel may fall in that category. This can be done by considering such facts as launch sites, launch vehicles, inclination, number of orbits, and even the number of payloads in the launch. Consult Appendix A for this information.

3. Report to the class any new information that you may discover in the news about new Soviet space launches. Give particular attention to such things as programs emerging from beneath the "Cosmos cover," new generations of the Luna program, and new developments in manned space flight.

4. Report to the class the significance of any of the "firsts-in-space" accomplished by the Soviets. Include the designation of the spacecraft involved, and such facts as launch site, launch vehicles, inclination, number of orbits, and the current status of the vehicle. If the "first" involved man, report on who was envolved. Consult both appendixes A and B and any other source available for this information.

SUGGESTIONS FOR FURTHER READING

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KOHLER, FOY D., HARVEY, DODD L. "The Soviet Space Effort—An Analysis," *Air Force Magazine*, June, 1971. (Reprinted in, Air Force RQTC *Readings in Astronautics and Space Operations*. Air University, 1971.

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U.S. Cong., House, Committee on Science and Astronautics, *Review of the Soviet Space Program*, 90th Cong., 1st sess, 1967, pp 11–78. (J115)

U.S. Cong., Senate Committee on Aeronautical and Space Sciences, Soviet Space Programs, 1966–70, 92nd Cong, 1st sess, 1971, Chapters 5–9.

THIS CHAPTER deals with the why and what next of the Soviet space program. It is divided into five major divisions and a summary. They are: Political Goals and Purposes of the USSR in Space; Organization of the Soviet Space Program; Resource Allocation and the Soviet Space Program; Soviet International Involvement; and Projections of Soviet Space Plans. After completing this chapter, you should be able to: (1) list the reasons for the Soviet political commitment to space exploration; (2) outline the organizational structure of the Soviet space program; (3) recall the degree of economic commitment now being made to the Soviet space program; (4) define the Soviet commitment to international cooperation; (5) list two examples of Soviet block cooperation in space programs; (6) list four examples of US/USSR cooperative space programs; (7) list two examples of USSR/French cooperative programs; and (8) outline and define where the various Soviet space projects are apparently headed.

POLITICAL GOALS AND PURPOSES OF THE USSR IN SPACE

Space triumphs have been used to glorify the Communist Party and the Soviet state. Soviet officials have attributed space successes to the effectiveness of the Soviet system. The foundations of the space program have been traced to Lenin and Marxist-Leninism Pride in space accomplishments has raised citizen morale, and the resulting prestige of space successes has been exploited for political value.

The Soviet leadership has made public its commitment to the space program in ceremonies for returned cosmonauts, monuments to space heroes (Fig. 47) and Cosmonautics Day (12 April). The Soviet Government appeals to the Soviet public for support of the space program by boasting of its significance and its practical applications.

Space activities have been used in an effort to tarnish the US image and to weaken the Western alliances. Space has also been used to strengthen the Soviets own bloc alliances through **Intersputnik** and **Intercosmos.** Cosmonauts not only build good will on foreign tours but actively take positions on current political issues, such as Vietnam and Cuba.

Although the Soviets have used their successes in space exploration for propaganda purposes, they disavow a space race, while emphasizing their many space firsts. This same contradictory position exists in the United States. Both the US and Soviet programs have reached the point of accomplishment, where both countries can take pride in their own successes while graciously recognizing the accomplishments of the rival state. Thus, cooperative programs should not be taken as a sign of decreasing rivalry.

ORGANIZATION OF THE SOVIET SPACE PROGRAM

It is difficult to obtain detailed information on the organization of the Soviet space program, and only through inferences drawn from known policies can the bits and pieces be put together.

Space policy decisions are made by the Communist Party, the Government, and the legislature, with ratification by the Presidium of the Supreme Court. The execution of policy is handled through the Council of Ministers (see Fig. 48). A **Collegium** (supervisory committee) supplies policy guidance from senior officials to the principal ministers, and a Scientific-Technical Council of senior scientists and engineers serves the Council of Ministers as consultants.

The USSR Academy of Sciences is responsible for the nonmilitary space program. In this role it reports directly to the Council of Ministers as a coequal with the various ministries. It has 15

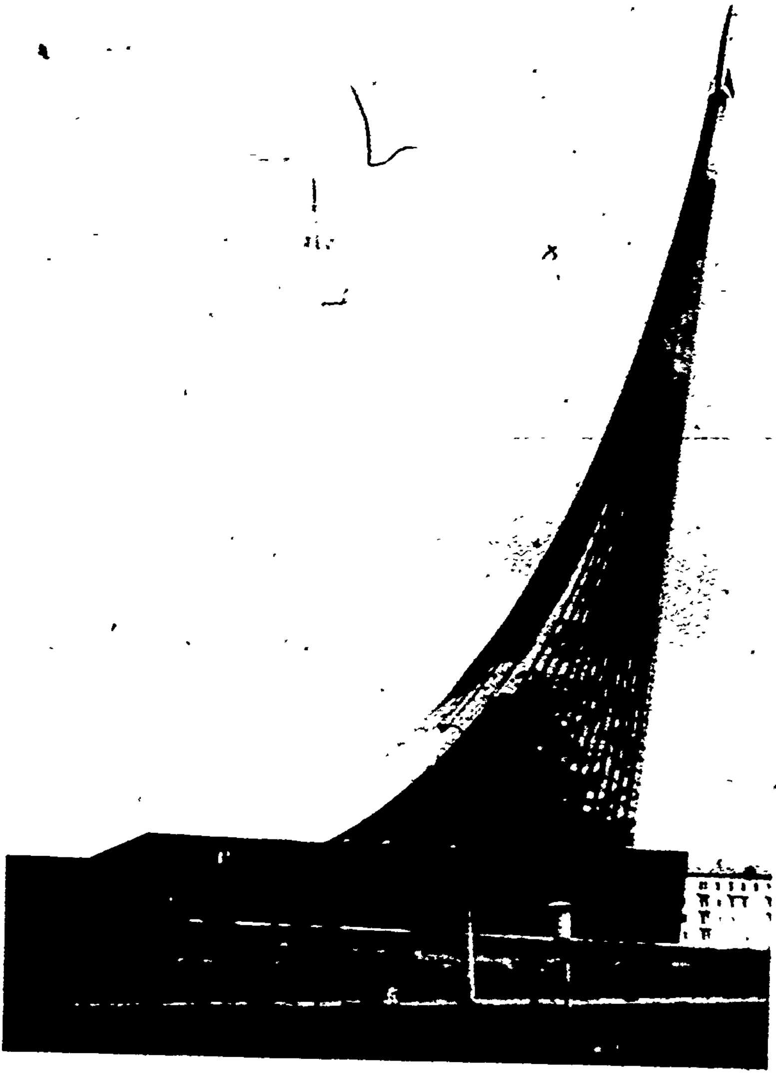

Figure 47. Obelisk (monument to the first man in space).

subject matter divisions, but it does not include one to deal with space. This omission is corrected by the existence of a high-level Commission on the Exploration and Use of Outer Space, which is delegated the authority to operate the nonmilitary Soviet space program.

The Defense Minister is responsible for the conduct of the large military portion of the space program and for the direction

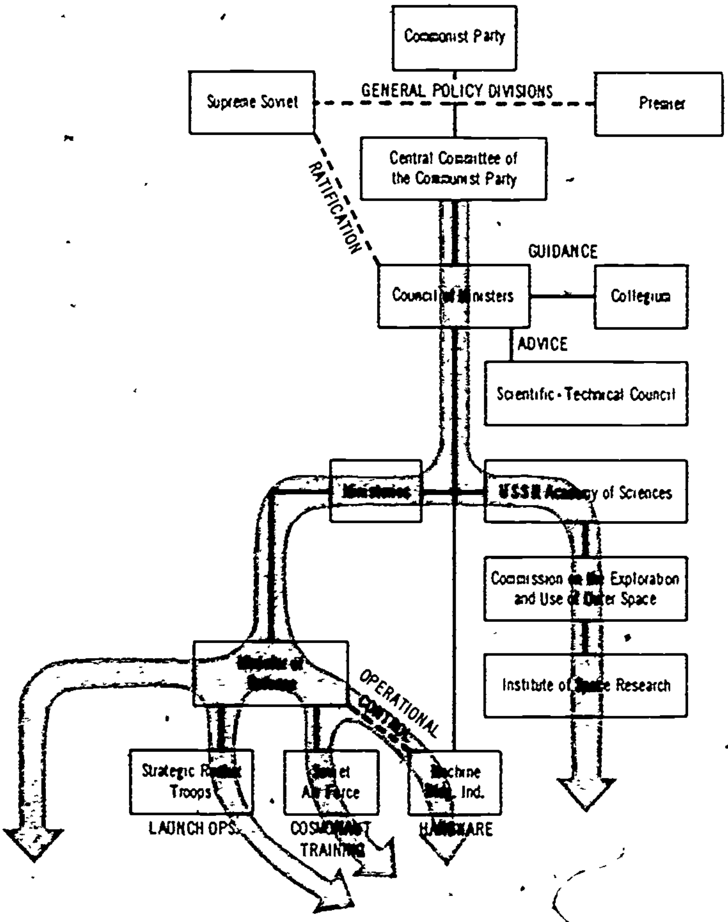

Figure 48. Organization of the Soviet Space Program.

of the industrial ministers (called the Machine Building Industry), which build much of the hardware, including the launch vehicles. It is also responsible through the Strategic Rocket Troops, a division of the Red Army, for providing launch services. The training of cosmonauts is conducted with the help of the Soviet Air Force.

In short, there is no single Soviet agency equivalent to NASA. Instead, there is a network of coordinating and interlocking bodies performing the work of policy making, manufacture, and operations. The only organization remotely similar to NASA is the special Commission on the Exploration and Use of Outer Space in the Soviet Academy of Sciences. This group is accorded broad policy making powers for nonmilitary programs, but even this commission is reduced to the role of liaison between other organizations in the military programs. Although the highest level bodies—Central Committee, Council of Ministers, and Supreme Soviet—have sections or committees that can deal decisively at high levels with space matters, no single branch of government has complete control.

RESOURCE ALLOCATION AND THE SOVIET SPACE PROGRAM

It is difficult to determine how much the Soviets spend on space research and operations because they have never announced a budget. This is consistent with similar secrecy surrounding national defense, atomic energy, computer development, and aviation. Space program financing is so subdivided that no single estimate would encompass the whole program.

The Soviet gross national product (GNP), an index showing the strength of the economy, has for some years remained somewhat less than half that of the United States GNP. Although allocations for consumer goods have made gains, they have not gained as much as allocations to capital expenditures (business expansion) and defense. Rising consumer expectations—the peoples' demands for things like ball-point pens, sliced bread, and hot running water—and rising national needs have created some strains in the economy, which is not growing as fast as it grew in earlier post-war years (1947-1957). The Machine Building Industry has enjoyed a fairly high priority, but it is not possible to uncover the numbers for special fields, which are given secret treatment. Although a defense budget is published, it is not regarded as meaningful.

At its peak, the space program of the United States spent about one percent of the US GNP on the combined NASA-DOD space effort. Today, it spends less than one-half of one percent. An examination of the total dimensions of the present Soviet space program, which is running at a level of hardware employment in excess of the US program at its previous peak, suggests that over two percent of the Soviet GNP is devoted to space today.

All of these estimates are so filled with guesses that attempts to quote precise figures are less meaningful than recognizing the reality of the massive commitment which the Soviet Government has undertaken in space. It is devoting three to four times the percentage of resources to space exploration that the United States is spending at present. Even more important, the Soviets are exceeding the largest annual expenditures of the US space program. If money spent has any effect on progress, the Soviet commitment to space exploration should carry them back into the lead in the space race.

SOVIET INTERNATIONAL INVOLVEMENT

This section deals with the Soviet effort to develop international space cooperation. Although these efforts are primarily extensions of the Soviet space program, some of them are aimed at unique goals and feature genuine cooperative effort.

Soviet Attitude

The Russians in principle, have professed to be strong supporters of international space cooperation. Chairman **Leonid Brezhnev**, in November 1968, said: "Outer space must be an arena of scientific research, of international cooperation, and not an arena of hostile clashes." A year later, in celebrating the successful flight of Soyuz 6, 7, and 8, he repeated the Soviet commitment to the principle of space cooperation: "We are supporters of international collaboration in the study of outer space."

Even cosmonauts have supported the principle of cooperation. Aleksei Leonov, the first man to walk in space, believes that international cooperation is imperative for the overall development of space science and that the Soviet Union is an enthusiastic promoter of such cooperation.

Soviet Bloc Programs

BEGINNING OF SPACE COOPERATION.—The Soviet Union has established a program of space cooperation with its East European allies. The total Soviet control over Eastern Europe has allowed the Soviets to structure this program and define the limits of cooperation according to their own purpose.

Since 1965, Soviet bloc space scientists have become increasingly concerned with two items. First, they are concerned with practical problems of space exploration. Second, they have sought a cooperative arrangement enabling each country to contribute to joint projects according to its scientific and technical potential and resources. Attention has focused mainly in such areas as physics, meteorology, communications, biology, and medicine.

In November 1965, representatives from the socialist states met to discuss the problems of formal arrangements for space cooperation. The Soviet Union proposed that this be accomplished through joint experiments, using Soviet satellites and research rockets. Not long after, an agreement on cooperation was reached, probably stipulating that the socialist countries would provide hardware for use in Soviet launches.

EXPANDING COOPERATION IN SPACE RESEARCH.—Between 1966 and 1969 Soviet bloc space cooperation expanded. During 5-13 April 1967, scientists from the Soviet Union, Bulgaria, Hungary, East Germany, Cuba, Mongolia, Poland, Rumania, and Czechoslovakia conferred in Moscow on ways to expand cooperation in space research and on peaceful uses of outer space. A program for joint satellite and rocket launchings was worked out. The Soviet Union also invited the other countries to install their scientific devices in satellites launched under the Soviet national program. (These events are sometimes called the Intercosmos Program because they are the basis for launching the Intercosmos satellite series in late 1968.)

In December 1967, Cuba and the Soviet Union reached an agreement under which the Soviet Union would construct a communications station in Cuba linking the island with Moscow via earth satellites. Dr. **Petrov** of the Soviet Academy of Sciences, referred to this arrangement as a **cosmic communications bridge** connecting Moscow with Cuba. Soviet and Cuban specialists were to build and service this station. (This unilateral agreement was a forerunner to the Intersputnik Program.)

In June 1968, scientists and specialists from Bulgaria, Hungary, East Germany, Mongolia, Poland, Rumania, the Soviet Union, and Czechoslovakia again met in Moscow and conferred on the matter of cooperation in space research. Their primary concern, as a working group, was space physics.

PROPOSAL FOR INTERSPUTNIK.—The Vienna Conference on the Peaceful Uses of Outer Space, sponsored by the United Nations in August 1968, provided the occasion for the Russians to make their proposal for a global communications satellite called **"Intersputnik."** The new system was presented as an alternative system to the American-sponsored INTELSAT. The Soviet appeal was designed to attract the attention of both the developing and advanced countries. According to Dr Thomas Paine, Director of NASA, Intersputnik was designed "to rival and embarrass INTELSAT," but, two years after its announcement, it had attracted only such close Soviet political associates as the United Arab Republic, Cuba, and the East European bloc nations.

Though Intersputnik may have failed in its political purposes, it still stands as a potential rival organization to INTELSAT in the field of international communications. Given the great potential for satellite communications systems Intersputnik could have worldwide foreign policy implications, especially in the developing countries of the world, by offering both an alternative communications system (to INTELSAT) and a plug for Soviet propaganda channels.

SUCCESS WITH INTERCOSMOS.—Soviet failures with Intersputnik were compensated by the success of intra-bloc cooperation in Cosmos 261 and the Intercosmos series (Fig 49). Perhaps the most significant experiment carried on by the Soviet bloc by the end of 1968 was the launch of Cosmos 261 on December 20. Scientific research institutes and observatories in Bulgaria, Hungary, East Germany, Poland, Rumania, the Soviet Union, and Czechoslovakia took part in this experiment designed "to study geoactive corpuscles, electrons, and protons that are the causes of the northern lights, electronics of super-thermal energy, and changes in the density of the upper layers of the earth's atmosphere during the northern lights."

The experiment with Cosmos 261 was followed by the Intercosmos series, the high point in the development of the intrabloc space cooperation during the past few years. Reports from the Soviet Union and Eastern Europe record such cooperative ventures as the launching of Intercosmos 1 in October 1969, Intercosmos 2 in December 1969, Intercosmos 3 in August 1970, Intercosmos 4 in October 1970, Intercosmos 5 in December 1971, and, finally, Intercosmos 6, 7, and 8 between April and November 1972. Scientific equipment from the participating East European states was used in these experiments, and all countries took part in carrying out observations and collecting data.

In connection with the Intercosmos program, Bulgaria, Hungary, East Germany, Poland, Rumania, the Soviet Union, and

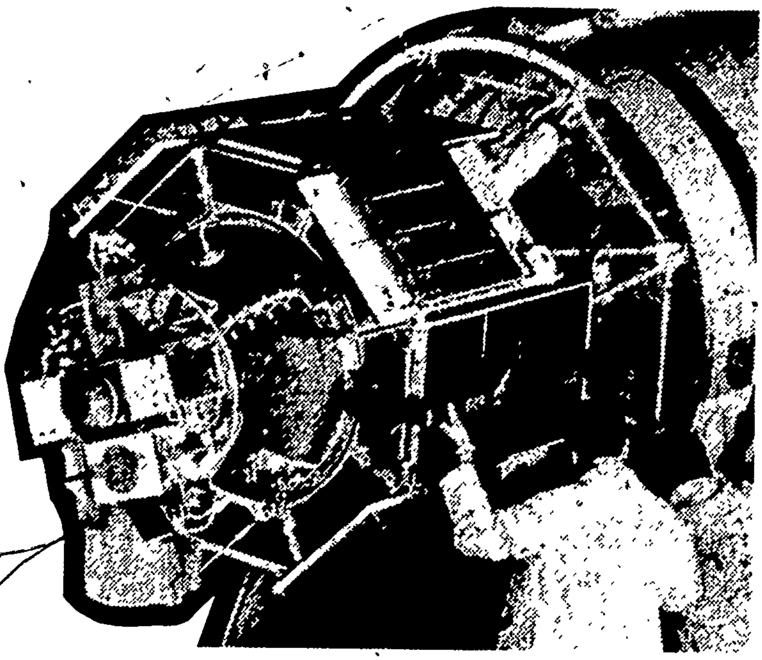

Figure 49. Intercosmos 1.

Czechoslovakia are carrying out a coordinated program of radioastronomic, isopheric, and optical observations.

During these launchings, the state flags of all participating countries were flown over the cosmodrome.

Programs with Free World Countries

In the early years of space exploration, Soviet secrecy and space rivalry limited the opportunities for space cooperation. But gradually, a more conciliatory environment has developed with a series of limited agreements between the United States and the Soviet Union, between France and the Soviet Union, and with more active Soviet participation in United Nations technical and legal organizations.

US/USSR COOPERATIVE EFFORTS.—In its official pronouncements, the Soviet Union has been committed to a policy of international cooperation with the United States. Individual Soviet scientists have been reasonably open in sharing the results of their experiments with their American counterparts when meetings are allowed. The United States has made cooperative agreements with 97 nations and has consistently pressed to extend such cooperative opportunities to the Soviet Union.

Early negotiations between the United States and the Soviet Union have resulted in a wide selection of proposals but no operational programs. Even US/USSR experimental programs have produced few constructive results. One such program was the "cold line" for exchanging weather data from satellites between Suitland, Maryland and Moscow. However, the data quality and timeliness have been disappointing. Also, little useful information has resulted from the agreement to exchange magnetic field maps Likewise, the effort to establish a joint passive communications experiment using Echo 2 was of little value. Similar results have been derived from efforts to standardize spacecraft sterilization, establish joint exploration of the Moon and planets, and create a "hot line" using communications satellites instead of ground communications.

At least, this was the story until 1971-1972. NASA's international activities during 1971 were marked by expanded discussions with the Soviet Union on a variety of possible cooperative undertakings and a broad range of joint activities (Fig.

50). Meetings in October 1970 and January 1971 produced an agreement on the exchange of lunar surface samples and specified a number of additional cooperative exchanges and arrangements to be the subject of detailed recommendations by joint working groups. These were:

- joint consideration and exchange of information regarding the objectives and results of space research by each side so that the other can use such research to the extent desired.
- substantial improvement of existing satellite weather data exchanges.
- coordinated studies by space and conventional means of ocean and vegetation surveys in agreed areas, and
- significantly expanded exchange of data on space biology and medicine.

PHOTO CREDIT—NASA or National Aeronautics and Space Administration

Figure 50. RUSSIAN SCIENTIST AT MSC—Russian Academician Alexander Vinogradov, left, examines a lunar rock collected on the Apollo 12 mission, during a visit to Houston and the Manned Spacecraft Center. Assisting the visitor is Dr. Michael B. Duke, center, curator in the Lunar and Earth Sciences Division of the Science and Applications Directorate at MSC. Dr. Robert R. Gilruth, MSC Director, is at right.

In September 1971, a joint US/USSR Editorial Board met to prepare and publish a joint review of space biology and medicine. The Joint Board reviewed the chapter materials already exchanged and selected authors to prepare the agreed upon selections of the review.

Three joint working groups, appointed to carry out the October 1970 agreement on compatible rendezvous and docking, met in June (1971) in Houston and in November and December in Moscow to detail the technical requirements. In addition, NASA and the Soviet Academy are considering the technical and economic implications of possible missions to flight-test the compatibility of US/Soviet systems.

The crowning action came during the space agreements signed during President Nixon's 1972 visit to Moscow (see Appendix E). While warming up for the arms limitations agreements, the President and Premier **Aleksei Kosygin** agreed to an inflight rendezvous and docking between an Apollo spacecraft and a Salyut space station. Astronauts and cosmonauts have already begun studies to overcome the barriers of communication and equipment differences.

COOPERATION WITH FRANCE.—Faster progress has been made between the Soviet Union and France than between the United States and the Soviet Union. Color television tests have been made a number of times between the two nations, using Molniya 1 satellites. In the past, both Presidents DeGaulle and Pompidou were taken to Tyuratam to observe space launchings. A French laser reflector (Fig. 51) was carried to the Moon by Luna 17, and scientists in both countries have reflected signals through it.

Although one program to launch a French satellite **Roseau** on a Soviet rocket was dropped for reasons of expense, **Oreol** I was launched in December 1971, and a series of new launchings, some independent and some French piggybacks (Fig. 52) on Soviet payloads, have been negotiated for the years immediately ahead. Both countries seem reasonably pleased with the progress to date.

Although, on the surface it appears that France has been involved in little cooperative activity with the Soviet Union, especially in relation to US/USSR agreements, two points should

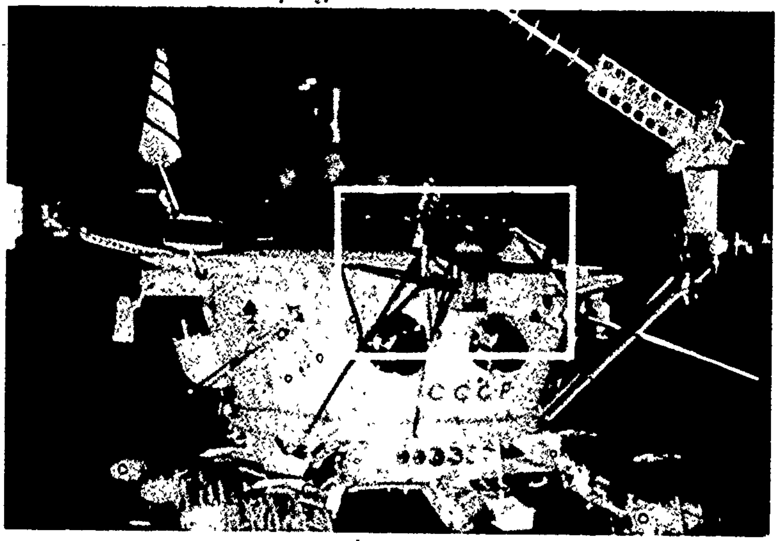

Figure 51. French laser reflector on lunkhod.

be remembered. First, France was welcomed into cooperation ahead of the United States. Second, France has actually participated in joint exploration, a level of activity not yet allowed the United States. As a result, French feelings of progress can be justified.

PROJECTIONS OF SOVIET SPACE PLANS

Soviet spokesmen comment constantly upon future Soviet space plans, usually without specific timetables. Even though so much is predicted, the Soviets must be selective among these many goals. Therefore, the real task of observers is to estimate their intentions rather than their broad technical capabilities. This task is an interesting reversal from the "missile gap" theories that US politicians were advocating only 10-years ago, when the cry was to ignore intentions and respond to capabilities.

Coming trends in the Soviet space program may be estimated from the clues of precursor flights, subsystems development, and the phrasing of Soviet public predictions. However the best estimates of the future may fail to materialize if external forces intervene or if Soviet policies are changed.

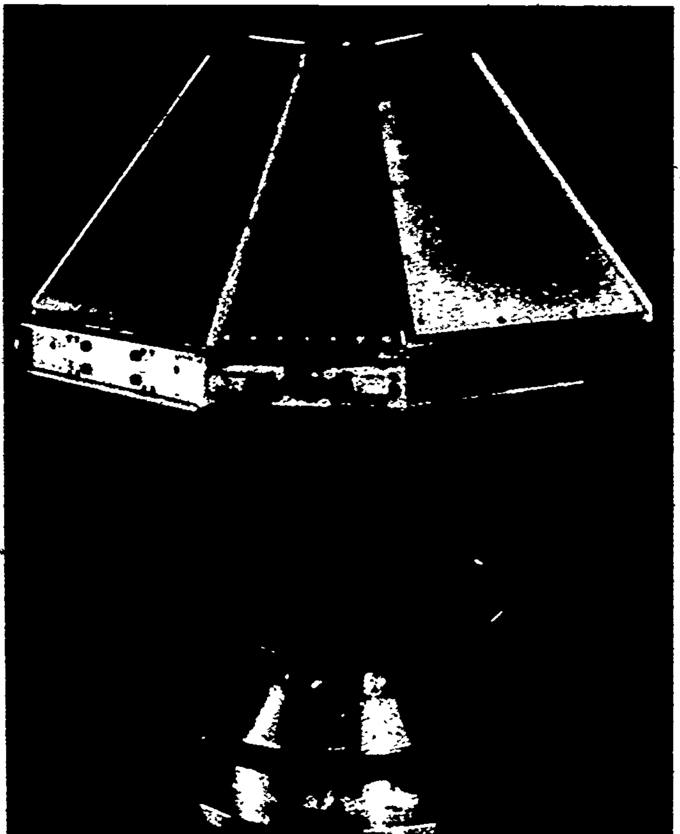

Figure 52. SRET: French-built piggyback craft.

General Technical Capability

The Soviet Union has built a complex of industry, experience, and manpower capable of supporting indefinitely its present high level of space flights and there is no reason to assume that the Soviets have any plans for reduction. The political claims made by Soviet leaders and the billions invested in space hardware guarantee a strong commitment to space. Each year thus far has seen greater activity than the year before. The existing launch vehicle system will support an ambitious program. There is a strong likelihood of a successful series G craft, the use of high energy fuels, the use of nuclear propulsion systems, and the development of reusable shuttle vehicles operated between earth and permanent orbiting stations.

Unmanned Space Flight

EARTH ORBITAL SCIENCE.—Statistical tables in the Appendix show fairly consistent Soviet application of hardware to work related to scientific goals in earth orbit. Much of this work is concerned with minor details and the quality of other finds has been questioned by US scientists. However, from what the Soviets have said, they will continue to see a place for more work refining their understanding of natural laws. Many of these flights will continue with unmanned craft of modest size.

The first decade of space exploration found only NASA with an extensive program of international cooperation in the space sciences. The Soviet Union now is expanding its cooperative efforts in this regard, principally through the Intercosmos series and the Soviet bloc participants and by working with the French.

CIVIL APPLICATIONS.—The Soviet Union was a latecomer to practical application flights compared with the United States. But Soviet concepts for civil application flights have been fairly imaginative and ambitious, especially in such areas as communications and weather. Based on their past record of achievement we should expect over the next several years distinct improvements and extensions of such activities.

Thus far, the Soviets have moved toward increased global coverage with weather and communications satellites and, probably, more navigation satellites. With increased coverage have come increases in the life and reliability of such Soviet equipment. Several of the systems have been moved from experimental to operational status.

MILITARY APPLICATIONS.—Since the largest single Soviet space program component is military, there is every reason to expect that this largely unpublicized area will continue to enjoy strong support This should be true without regard to the Strategic Arms Limitation Treaty (SALT) talks, although the new treaty arrangements may alter the product mix of hardware for military space flight. For example, an agreement to limit ICBM deployment could result in additional FOBS placement or improvement of interceptor destruct satellite capabilities.

Because of the high priority accorded by the Soviets to photographic observation from space, recoverable payloads, and the development of more versatile payloads, this work should continue to progress. By now, there seems a reluctant acceptance that observation flights are important to both sides in avoiding tactical, as well as strategic surprise, and in policing any arms agreements that may exist. Photographic observation flights may reduce overall military expenditures. Military planners would be able to reduce defense spending by producing more reliable information on the force deployment and the construction work of their military rivals

The few facts available suggest that the Soviets are having some success with electronic ferreting flights (see chapter 2) involving communications, radar, and other electromagnetic signals The number of flights that may carry out such collection is fairly large, indicating that the work is important to the Soviets Ultimately, as observation satellites increase in number and complexity, one must assume that the world will be increasingly an open book to the Russians and to other nations.

In another area, Soviet work on FOBS flights seems moderately quiet and stable at this point, and it would be difficult to predict any substantial change in this regard in the years immediately ahead. It would be safer to assume that a number of the existing and coming SS-9 silos will be programmed for use of F-1-r FOBS payloads.

Soviet work with space interceptors is still so actively expanding that it is difficult to ascertain where this development will lead. The variety of interception tests seems to be expanding. The Soviet program seems pointed toward a very real capability to make fast passes by target satellites and to co-orbit with them We do not know how successful gathering intelligence about such target satellites will be. Destroying target satellites has not been employed up to the time of this writing, but such a destruction capability appears to be a relatively simple engineering addition, compared with the solution of the problems of interceptive inspection.

Finally, any Soviet development of a multiple orbital bombardment system (MOBS) cannot be forecast at this point There is no clue whatsoever that such a system already exists. To a degree, the world may be protected by the existing Outer Space Treaty (see chapter 5), which prohibits orbital stationing of weapons of mass destruction. Violations of the treaty probably would be caught during the development phase so that strong protests could be made before such a system became operational.

LUNAR STUDIES.—The examples of Zond 5-8 and Luna 15-20, coupled with repeated Soviet forecasts, suggest a continuation of the Luna program. In time, the Soviet Union can be expected to map the entire lunar surface, to land roving laboratories in several regions of the moon, and to bring home sample materials from various lunar sites. If the G-1-e vehicle is applied to unmanned lunar work, then much more ambitious projects may be carried out during the remainder of the 1970s.

PLANETARY STUDIES.—Probably, the most immediate planetary task will be to send additional payloads to Mars, in light of all the Soviet statements about that planet. A token round trip flight to Mars is probably within the capacity of the D-1-e vehicle. Such a flight would not include landing. It may be assumed that the Soviets will attempt multiple launches toward Mars during the 1973 and 1975 windows.

Also, Soviet flights to Venus should continue at appropriate **window** (planetary alignment) opportunities. The Soviet Union probably will try for a longer period of payload survival on the surface, with more sensors working than was true of Venera 7. If the Soviet Union upgrades the D-1-e vehicle for Venus flights, then the variety of data-gathering can be greatly increased. Flights might be put into orbit around Venus, returning data for a time before making a landing.

Finally, Soviet flights to the giant planets (Jupiter and Saturn) and the other outer planets appear likely at some future date. However, there is no indication of planning for a planetary **grand tour** during the 1976-1979 "grand-tour" window. Jupiter seems likely to be the earliest fly-by target for future Soviet space probes going to planets other than Venus and Mars. The D-1-e vehicle would be the logical vehicle to use. Soviet scientists also have shown an interest in studies of the asteroids, comets, and other space phenomena of the solar system. However, Soviet deep space operations are strictly secondary to near-earth efforts.

Manned Space Flight

SOYUZ.—Even though the Soyuz manned craft has not yet been used to its announced limits of 30 days stay time and 1,300 kilometers altitude, it has been proposed as a ferry and resupply craft, as well as an element in early space stations. Also, group flights with hard docking attempts are a logical probability within the Soyuz program. It is possible that these two missions might be combined, although there would need to be some trade-offs in use of weight carrying capacity between consumables for men and fuel for maneuvering.

LONG TERM SPACE STATION.—The most consistently quoted Soviet estimates of the establishment of a permanent station seem to center around 1974. It probably will take place eventually even if such a station has to be constructed primarily of many separate components placed in orbit by either the A-1 or the D-1 vehicle. The G-1 vehicle might be used to orbit one or more major elements. A station with a five-year life might start out fairly modestly, and then be expanded each year. There is still too much speculation to provide any definite clue as to whether it will be constructed with spokes around a hub or as a **toroid** (doughnut-shaped). One possibility is that the next step may be the **manned orbital platform** (MOP) whose core is to be placed in orbit by the G-1-e vehicle.

Although the Russians speak of several stations, some in polar orbit and some nearly equatorial, it seems unlikely that, in the 1970s, they would be able to afford several simultaneous large efforts. Inclinations of 52 degrees or 65 degrees appear to make the most sense for continued passage over the launch site and scrutiny of most of the important parts of the Earth. The permanent station, when it comes, is expected to serve many economic and scientific purposes in weather reporting, locating earth resources, communications, and navigation.

REUSABLE SPACE SHUTTLE.—If the Russians build and supply many orbital stations, a reusable shuttle would justify its estimated development cost very quickly. It is difficult to forecast when such a shuttle will appear, but the most likely period for such a development is between 1975 and 1985.

ZOND.—Because the Zond has been so clearly identified as a manned precursor and seems to incorporate two of the three parts of the tested Soyuz craft, presumably, it will be used to send a human crew around the moon. One obstacle has been the difficulty in man-rating the D-1-e vehicle. Another obstacle has been the Soviet desire to test several modes for earth return, both ballistic and lifting reentry. The latter is preferred for manned flight. With only the Zond 6 and 7 experience in lifting reentry, it is possible that at least one more unmanned test flight will be run under the label Zond 9 before men are committed.

MANNED LUNAR LANDING.—Western observers of the Soviet space program may debate for some time to come whether the Russians really thought that they would be ready to land men on the moon in 1969 or whether such a program lay several years in the future. The real issue is not whether the Russians had a moon program but whether there was a firm, time-table and hardware in production to back up such a timetable. Further, there is the issue of whether there still is a Soviet moon landing program. The Russians more likely than not had specifically prepared hardware for the lunar attempt. It is conceivable that some space engineering group had a plan for overcoming the very real obstacles to early success and for some months in 1969 had the go-ahead for a good try to be first to land men if the Apollo 11 mission failed. But such a venture probably could not have been undertaken without violating the conservative practices with regard to human safety which the Russians have followed fairly consistently in their program. Such a mission would have been marginal at best. Earlier, the unmanned Luna 9 beat the US surveyor I mission to the moon by several months, but Luna 9 had been rushed to the point that it was only a token action. The difference with a manned flight was the chance that a token effort would cost the life of a cosmonaut.

There is insufficient evidence to prove that plans to land men on the moon have been abandoned. The safest assumption would be that, if years of work have gone into preparing hardware and other facilities and plans for a lunar landing, some effort is continuing to prepare for this event. It is still a reasonable assumption that whatever went wrong with Soviet manned lunar flight plans in the summer of 1969, something brought a shift in priorities away from the earliest possible manned round trip lunar landing toward somewhat greater emphasis on earth orbital station plans.

From 1973 on, with the Apollo missions completed, one may realistically assume that the Russians may feel that they have had the time for methodical preparations which they need to make their own landing. If work continues to go slowly, it may be the late 1970s or early 1980s before a landing takes place.

MANNED PLANETARY FLIGHT.—Manned flight to the planets has been the long-range goal of the Soviet space program from its beginning. If the Russians develop a space shuttle by 1980 or earlier, the chances of their sending a manned expedition to the planet Mars before the 1980s would be greatly improved. Considering the number of engineering and scientific accomplishments still to be achieved, it is probably most realistic to estimate a Soviet expedition of 20 or so men to Mars in the 1990s.

Soviet Philosophy Toward Their Space Program

The Russians have taken pride in their space accomplishments and have not been hesitant to exploit the prestige associated with their successes. Space technicians seem to have convinced the political leadership, which often has an engineering background, of the economic necessity and benefit of pursuing an expanding program of exploration and application.

However, the Soviets have not overlooked science and discovery for its own sake. If space research and development has involved any delay in improving the lot of the consuming public, it is part of a broader philosophy of sacrificing the present for the chance to improve the lot of all in the future, the Communist "pie in the sky" philosophy.

CONCLUSION

Overall, the Soviet space program is pursued in an orderly fashion, while seeking multiple goals. The investment in support of these goals is substantial and, probably, is in excess of that given the US program at its peak.

The Soviet space program has been used extensively as a propaganda medium for the Soviet Union, its form of government and the Communist Party. The decline of this government analog would be severely damaging politically. At the same time, the Soviets have made a massive commitment to the space program, most of which would be wasted if the space program winds down. Finally, the Soviet Union has evolved space cooperation into an extension of foreign policy. Such international tools as dual docking, Intersputnik, and Intercosmos would be lost by decreasing space exploration.

Thus, one may logically assume that the Soviets will continue to build a space station during this decade and will complete manned landing and exploration of the moon in the 1980s, possibly in joint efforts with the United States. And should be reaching for Mars in the following decade. At the same time, additional improvements should be seen in military and civilian application, unilaterally and collectively, in the near-earth zone.

WORDS, PHRASES AND NAMES TO REMEMBER

Intersputnik
Intercosmos
Collegium
Leonid Brezhnev (leh-yah-NEED BREZH-neff)
Petrov (pi-TROFF)
cosmic communications bridge
Aleksei Kosygin (ah-lek-SAY kah-SEE-gin)
Roseau (roh-ZOH)
Oreol
multiple orbital bombardment system (MOBS)
window
grand tour
toroid
manned orbital platform (MOP)

QUESTIONS

1. List two political analogs of the Soviet space program.
2. Name three administrative agencies which are believed to share control of the Soviet Union's space program.
3. In terms of GNP, compare the current resource commitments to space exploration of the United States and the Soviet Union.

4. What are the two major Soviet bloc cooperative space programs?
5. Name four Soviet-United States cooperative projects.
6. Name two Franco-Soviet cooperative projects.
7. Despite the volume of activity in ____________ space flight, the core of the Soviet space programs is ____________ space flight.
8. Based on this chapter and any supplemental sources available, list the next three probable developments in the Soviet space program.

THINGS TO DO

1. Report to the class on the structure of the Soviet Government. Make an organizational chart of the structures of both the Soviet Government and the Soviet space program. See what comparisons can be made between the two charts.
2. Make two color bar graphs to illustrate the differences between US and Soviet spending on space exploration. The charts should be based on both dollar equivalents and GNP percentages over a period of a few years to make both actual and relative comparisons.
3. Report to the class on any new developments in the Soviet space program. Be sure to note if such developments are consistent with, ahead, or behind current expectations.

SUGGESTIONS FOR FURTHER READING

FRUTKIN, ARNOLD W. *International Cooperation in Space*. Englewood Cliffs, New Jersey: Prentice-Hall, 1965, chapter 3.

STOIKO, MICHEAL. *Soviet Rocketry: Past, Present, and Future*. New York: Holt, Reinhart, and Winston, 1970, chapter 15.

U.S., Cong., House, Committee on Science and Astronautics, *Review of the Soviet Space Program*, 90th Cong, 1st sess, 1967, pp 79–89. (J 115)

U.S. Cong., Senate, Committee on Aeronautical and Space Sciences, *Space Cooperation Between the United States and the Soviet Union,* Hearings, 92nd Cong, 1st sess, 1971.

U.S., Cong., Senate, Committee on Aeronautical and Space Sciences, *Soviet Space Programs*, 1966–70, 92nd Cong, 1st sess, 1971, chapters 1–3, 10, 11.

Worldwide Space Involvement

THIS CHAPTER deals with the "other" space programs of the world. The primary programs are those of the United States and Soviet Union. These programs have already been discussed in previous chapters of this text and three other AE-III texts.* This chapter discusses national programs that you thought never existed and international space projects that, combined, could someday rival those of the United States and the Soviet Union. After completing this chapter, you should be able to: (1) list and define at least 10 national space programs, (2) name and list some of the activities of the three most significant international space programs, (3) list eight other nations besides the United States and Soviet Union that have placed satellites in orbit, and (4) give three examples to show how space exploration has directly benefited the common people.

To prevent confusion, this chapter is divided into four major parts: Europe, the Americas, Australia-Asia, and the United Nations. Under each of the three geographic divisions, both regional international programs and major national programs are discussed.

EUROPE

Most of the nations of Europe began their space programs with assistance from the United States or more prosperous neighbors. As they progressed, they reached a point where they could afford regional cooperation and began international programs. Most recently, the dominant theme has become national programs, and, as a result, the regional programs have begun to fade.

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*Space Exploration. Manned and Unmanned Flight. Space Technology. Propulsion. Guidance. and Control of Space Vehicles: Human Factors in Aviation and Space.

There are two major international cooperative programs in Europe. The **European Space Research Organization** (ESRO) is primarily concerned with satellite operations, and the **European Launcher Development Organization** (ELDO) works to produce an all-European launch vehicle. In addition, ESRO and ELDO, along with the United Nations, constitute the three largest international space programs in the world.

European Space Research Organization (ESRO)

On 17 May 1968, the number of nations that had participated in orbiting a spacecraft more than doubled. Seven new nations were added to the list, not because of a sudden surge in national launch activities—only one satellite was involved—but because ESRO 2B (Fig. 53), the cooperative effort of 10 European countries, was placed in orbit by the United States.

The European Space Research Organization came into being in March 1964 after some three years of preparation. It consists of 10 member nations: the United Kingdom, Germany, Italy, France, Sweden, Belgium, Netherlands, Switzerland, Spain, and Denmark. Its stated purpose it to "provide for, and to promote, collaboration among European states in space research and technology, exclusively for peaceful purposes."

ESRO has the responsibility for designing and constructing sounding rocket payloads and space probes, using equipment provided by its member states. It is to obtain (but not build) launch vehicles, arrange for their launching, and provide a way to collect and analyze the data obtained. The organization has the overall job of exchanging information and promoting cooperation among scientists of the member nations. It also has the authority to enter into contracts with ESRO member states or with other nations or international organizations for the use of launch ranges and other facilities. For example, ESRO has signed working agreements with NASA. The ESRO-NASA emblem, Figure 54, is placed on vehicles involved in their joint endeavors.

In addition to ESRO 2, ESRO has placed four other satellites in orbit: ESRO 1, launched in October 1968, was a scientific spacecraft to study the polar ionosphere, northern lights, and related phenomena. **HEOS** 1 (High Eccentric Orbiting Satellite),

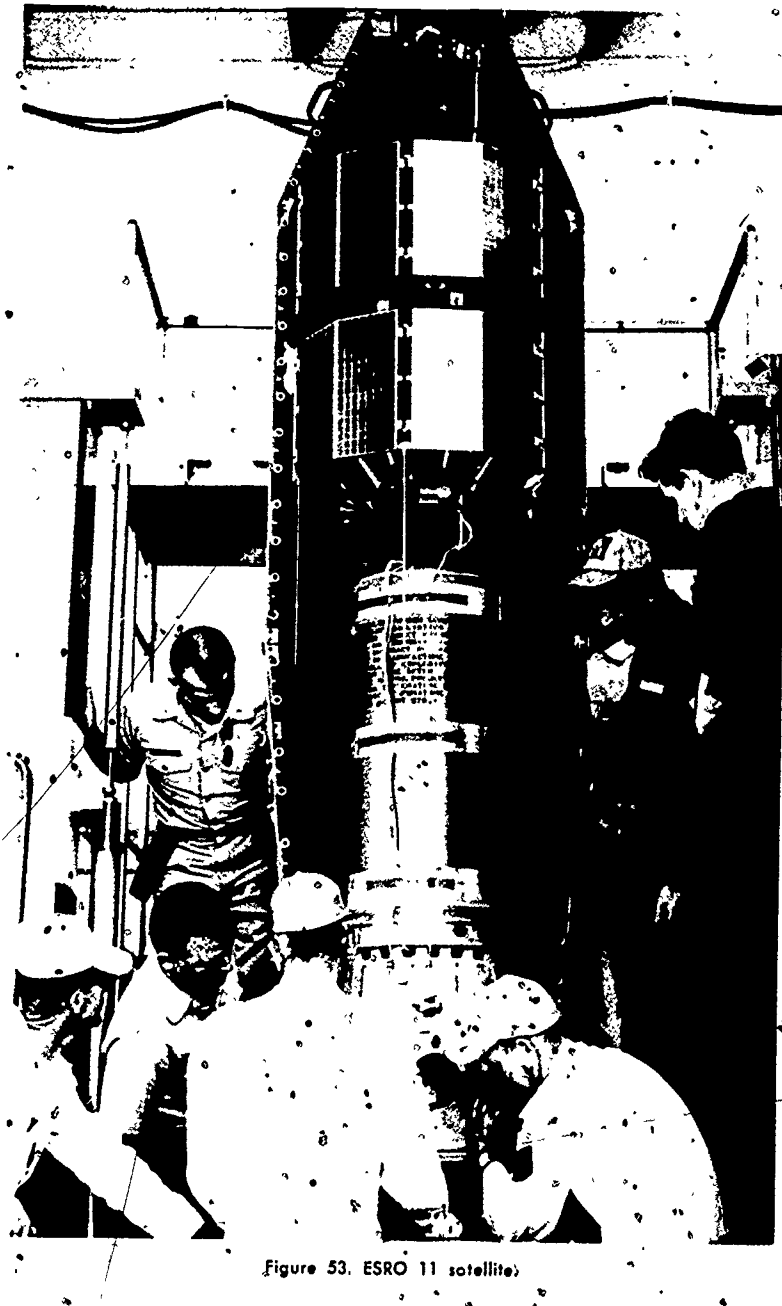

Figure 53. ESRO 11 satellite

Figure 54. Emblem designed for joint projects between NASA and ESRO.

designed to chart the magnetosphere beyond the earth's shock wave, was placed in orbit in December 1968. ESRO 1B was launched in October 1969 to study ionospheric phenomena and the aurora borealis. Finally, HEOS 2 continued the charting begun by HEOS 1 after it was launched in 1972. (See Figure 55.) For all these efforts, ESRO employed US launch vehicles.

For the future, dim prospects await ESRO. France and Germany have withdrawn for political and financial reasons, while Italy, the United Kingdom, and the Netherlands have turned to national programs.

European Launcher Development Organization (ELDO)

To date, ELDO has failed in its attempt to produce a reliable launch vehicle (Fig. 56) even though France and the United Kingdom, both member nations, have developed their own launch vehicles. Such inconsistencies are typical of the ELDO pact members. ELDO appears to be headed for the same fate as ESRO, a slow death caused by too many nations with too many differences sharing the role of administration. In attempting to mix politics with technology, both ESRO and ELDO have encountered numerous problems, most of which have come from a lack of political and technical centralization, poor division of responsibility, and considerable mistakes in budgeting.

Other Programs

In addition to ESRO and ELDO, there are several smaller and less important programs. Three typical examples are CETS, EUROSPACE, and FAI.

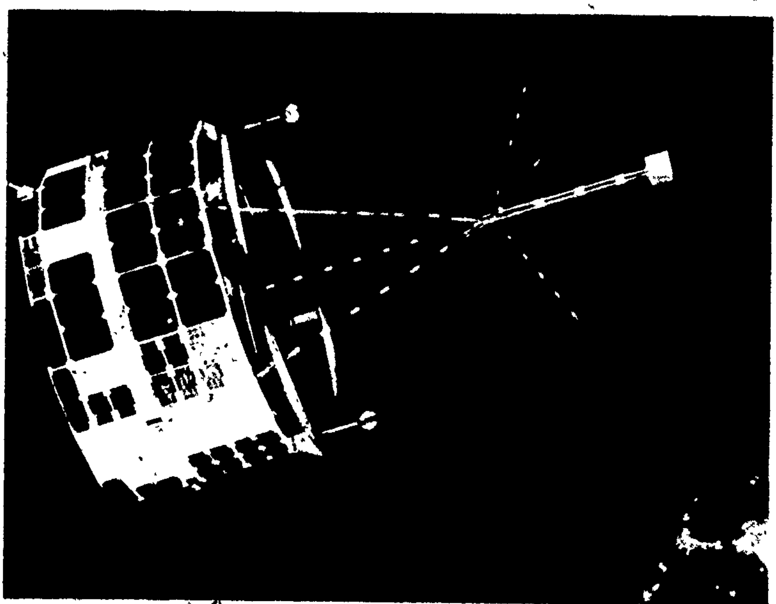

Figure 55. HEOS II, ESRO solar research satellite.

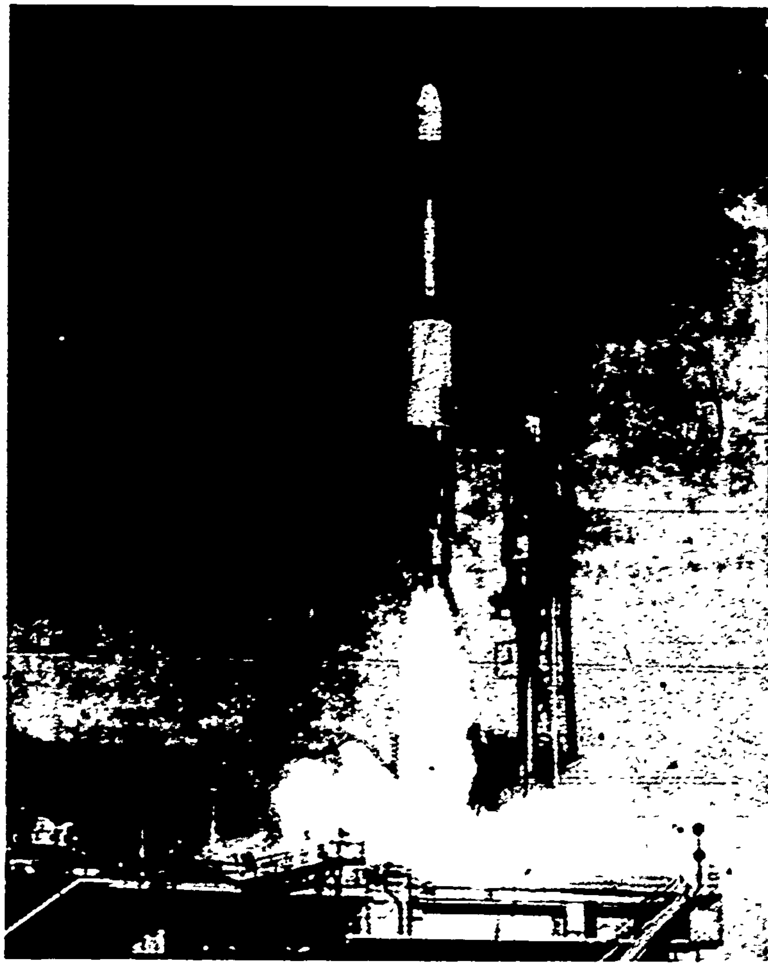

Figure 56. Europa II, ELDO launch vehicle.

CETS.—One of the important nongovernmental organizations in Europe is the **European Conference for Telecommunications by Satellite** (CETS, the organization's acronym, is derived from the first letters in the French title of the organization.) As its name implies, CETS is primarily concerned with satellite communications. It was organized in 1964 as a unified voice to speak for the European nations in discussions on worldwide communications satellite networks and to protect European interests in the field of communications.

CETS represents 17 European nations in INTELSAT CETS is not funded from governmental budgets but is kept operational by donations from industrial concerns. CETS is the European counterpart of the Communications Satellite Corporation (Com-Sat) A major project of CETS is the establishment of a European satellite network. The CETS network plan calls for the use of ESRO facilities and ELDO launch vehicles, but, until these two governmentally operated bodies achieve success, the CETS system remains a future plan.

EUROSPACE —The **Committee for European Space Research** (EUROSPACE) was organized in 1961. It is composed of members representing scientific, engineering, aircraft, electronic, chemical, and financial interests of Western Europe in the field of space research It describes itself as "a free association of industrial firms and professional bodies interested in the scientific, technological, and industrial aspects of space."

EUROSPACE has become, perhaps, the most dominant of the European space groups. It supports ESRO, ELDO, and CETS in their various programs and acts as a defender and promoter of space research in governmental circles and among the general public. In addition, EUROSPACE has a number of committees at work on all aspects of space flight, such as basic research, training, law, and documentation of efforts in space.

EUROSPACE also works for cooperation through the European Space Conference (ESC). The ESC is currently working on two programs: (1) an agreeable post-Apollo cooperative space shuttle program (with the United States) and (2) a European NASA. A European version of NASA would result from combining ESRO and ELDO.

FAI —The Federation Aeronautique Internationale (FAI), or **International Aeronautical Federation,** was founded two years after the Wright brothers' flight and has since developed many aviation regulations that are basic to international law. FAI has become recognized as the body that certifies world records in aeronautical flight, and this power to certify has been extended to space flight records The FAI regulations governing all classes of aircraft competition are modified periodically to keep pace with technological changes in air and space craft. The FAI has been most closely identified with outer space in the area of certifying world records.

National Programs

Aside from international organizations, Europe is fast becoming an area where national programs are dominant. In several instances, national programs are more successful than international programs even when the same countries are involved.

UNITED KINGDOM —The United Kingdom began exploring space with the assistance of the United States. Soon, however, the United Kingdom turned from the United States to the ESRO and ELDO programs. But, in the 1970s, the UK space effort has taken a new direction. Faced with financial and other restrictions, the United Kingdom has redirected its space program by again working closely with the United States and is developing its own national programs, giving only limited support to ESRO and ELDO.

The British satellite **Ariel** 1 was launched by NASA in April 1962. Ariel 2, another cooperative venture, was launched in March 1964 to measure atmospheric phenomena. The sophisticated Ariel 3 was orbited in May 1967 and was the first all-British research satellite. Ariel 4 (Fig. 57) was launched from Vandenburg AFB in December 1971. It was a cooperative project to investigate phenomena in the upper ionosphere.

In recent years, major British effort has focused on the **Skynet** military communications and **X-3** research programs. On 19 November 1969, the first satellite in the Skynet program, Skynet 1A, was launched with a NASA Thor-Delta rocket from Cape Kennedy to a geostatic position over the Indian Ocean. The second satellite was launched on 19 August 1970, but it failed after a few moments. When Skynet 1B is replaced with the improved Skynet 2 (all-British construction), it will form a military communications network between Whitehall (the British Pentagon) and distant British bases and units. The X-3 was Britain's successful bid to become the sixth nation to orbit its own satellite. In late October 1971, a British **Black Arrow** rocket (Fig 58) lifted the X-3 (Fig 59) technological satellite into orbit from Woomera, Australia. The X-3 is designed to test a new telemetry system, power supply equipment, thermal control surfaces, and solar cells.

The British are proud of their ground facilities, particularly the famous **Jodrell Bank Radio Telescope.** Jodrell Bank has played a significant role in covering each of the Apollo flights. It provided invaluable assistance in the recovery of Apollo 13. Because of its location in the northern longitude, this telescope was the first ground-based facility to pick up and report the position of the crippled craft after each Moon orbit.

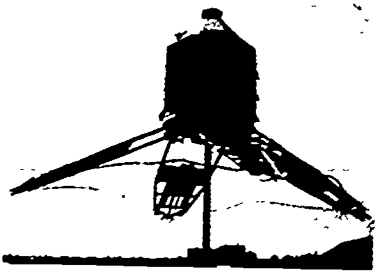

Figure 57. Ariel 4.

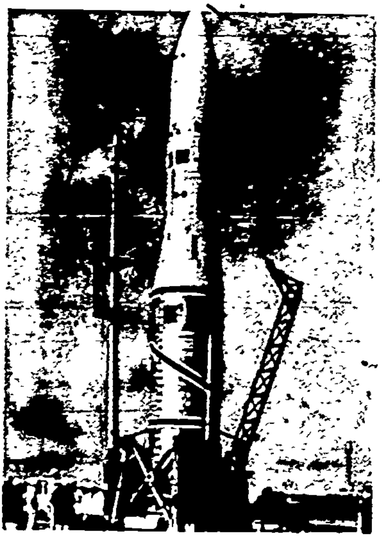

Figure 58. Black Arrow.

ITALY.—The most famous Italian space effort has been the **San Marco** satellite project, conducted in cooperation with NASA. Italy was one of the first nations to accept NASA's invitation for cooperative space experiments, and the San Marco project was the result. In the project, Italy provided the first satellite launch conducted in the United States by a foreign team and the first launching from a mobile platform. San Marco is an air density satellite. San Marco 1, a test satellite, was launched from Wallops Island, Virginia, in December 1964, it decayed 10 months later San Marco 2 was launched on 26 April 1967 from the San Marco launch base, a mobile sea-based platform in the Indian Ocean off the coast of Kenya (Figs 60 and 61). It transmitted air density and ionospheric data. The launch vehicle was a Scout rocket provided by NASA. San Marco 2 was followed by San Marco 3 (24 Apr 1971) which duplicated the former satellites mission. Italy also conducts sounding rocket and balloon-borne space projects from the Satto di Quirra test range in Sardinia. It operates one of the most expensive and varied space research programs in Europe, ranging from measuring cosmic radiation, proton energy, and the earth's magnetic field to expanding satellite communications above the 10 GHz (Giga-Hertz, 10^9) frequency range,

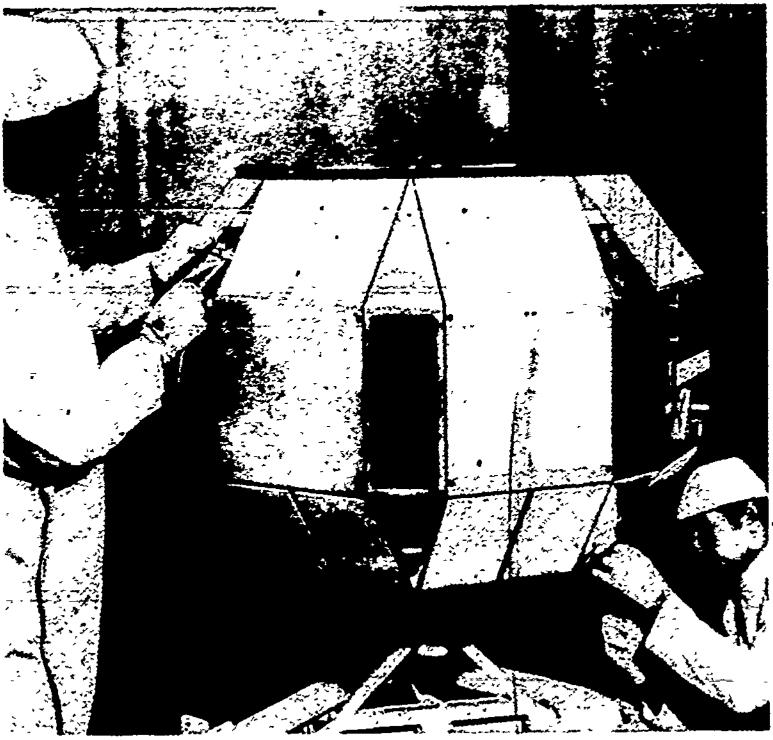

Figure 59. X–3.

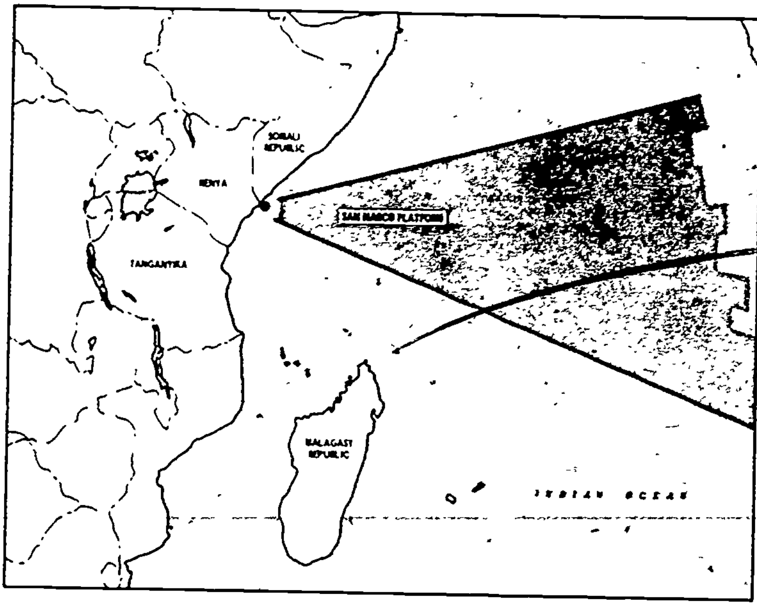

Figure 60. San Marco Launch Site.

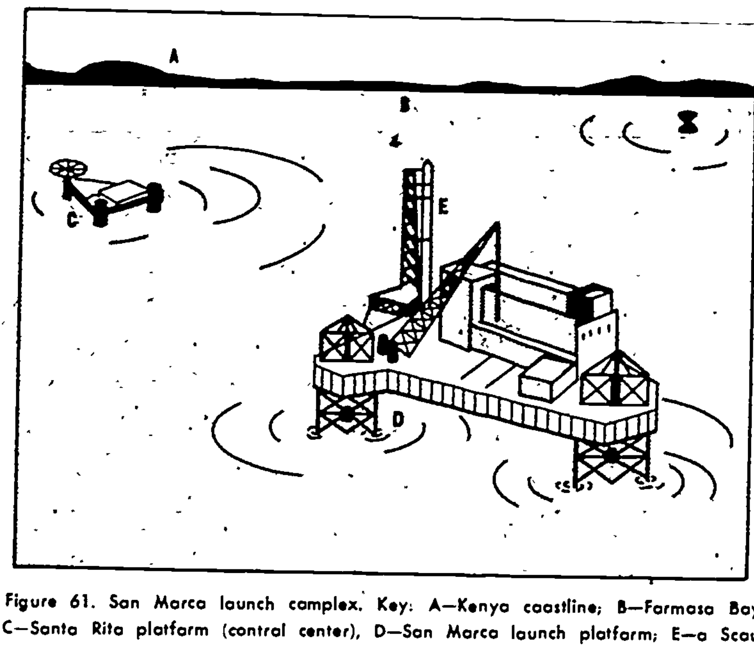

Figure 61. San Marco launch complex. Key: A—Kenya coastline; B—Formosa Bay, C—Santa Rita platform (control center), D—San Marco launch platform; E—a Scout rocket in launch position.

an area still open to research and a potential relief to overcrowded normal communications frequencies.

In December 1970, Italy launched the US Explorer 42 or **Small Astronomy Satellite** (SAS–A) from the San Marco platform. This marked the first time that a foreign country launched a US satellite.

Italy's most important satellite project is the **SIRIO,** (Fig. 62) a national program. This will be a geostationary communications/ scientific satellite intended to test communications in 12-18 GHz frequency range. The CNR (Italy's National Research Council)

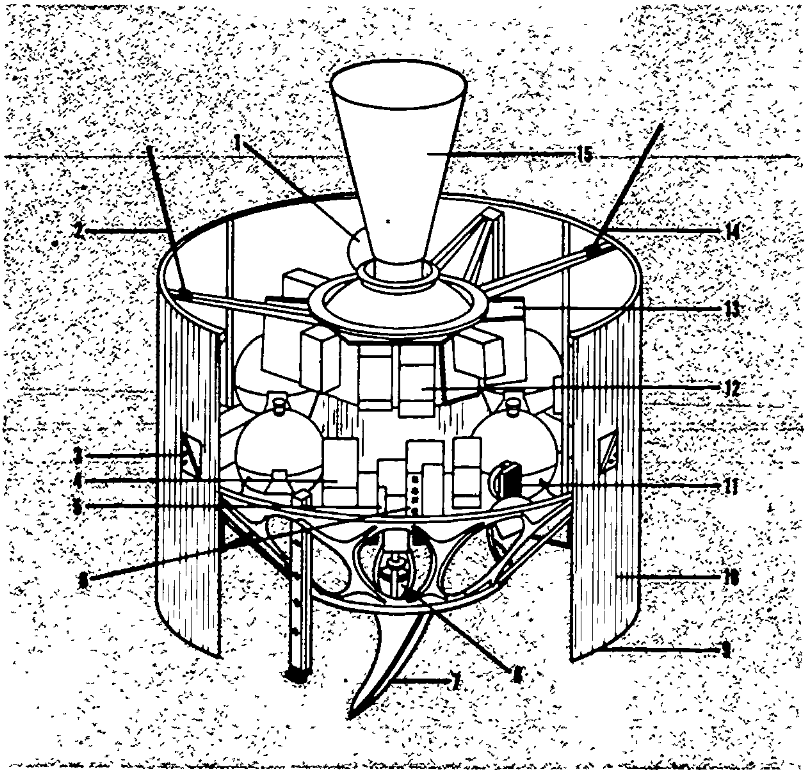

Figure 62. Italian SIRIO communications scientific satellite. Key. 1—ETA–BETA experiment, 2—VHF antenna, 3—colatitudinal sensor, 4—digital counter, 5—medium energy sensor, 6—high energy sensor, 7—SHF experimental antenna, 8—SHF transponder; 9—satellite housing, 10—solar cells, 11—level sensor, 12—analog digital converter; 13—telemetry encoder; 14—UHF antenna; 15—apogee motor.

plans to launch the satellite into a 22,000 mile geostationary orbit at 15° west longitude. NASA will use a Delta rocket to make the launch.

Italy participated in both the ELDO and ESRO programs for several years, but, in recent years, the Italians have been disappointed in intra-European cooperation, primarily because of financial conflicts. Through 1971, Italy contributed 57.6 million dollars to ELDO and received only 41.6 million dollars worth of equipment orders. At the same time, Italians spent 35.2 million dollars on ESRO to gain only 9.6 million dollars in parts orders. Faced with these returns, future Italian efforts will most likely center on the San Marco program and national projects.

FRANCE.—After the Soviet Union and the United States, France was the third nation to place its own satellite in orbit with its own rocket. Today, France is as much involved in international programs as in independent ones. In addition to developing its own carrier rocket, **Diamant**, France devotes most of its effort in the nonmilitary area to working with the ELDO nations in their attempts to perfect the **Europa** satellite launch vehicle. So far, however, the Europa has proven unreliable, having failed on all nine launches on which it has been used.

France has developed two primary rockets of particular significance. The first is **Coralie**, the French contribution to ELDO, which is the second stage of the ELDO Europa I and II boosters. This rocket has been successful in every Europa launch, despite the Europa record of failure. In each case of Europa failure, the problem has been in the German third stage. The second French rocket of importance is the Diamant, an entirely French project. The first version, Diamant A, was used to orbit four satellites, the A-1, D1-A, D1-C, D1-D, all French. The more improved version, Diamant B (Fig 63), has been used to launch the German **Dial** satellites and the French **Peole** satellites.

The majority of French launches are staged at CSG, Centre Spatial Guyanais the **(Guiana Space Center)**, at Kourou, French Giuana, in SouthAmerica (see Fig 64). The facility has four functional areas: a Europa launch site, a separate Diamant launch site, four platforms for sounding rockets, and a tracking station (see Fig 65). The tracking station at CSG is part of the system that includes facilities in France, the Canaries, Haute Volta (East

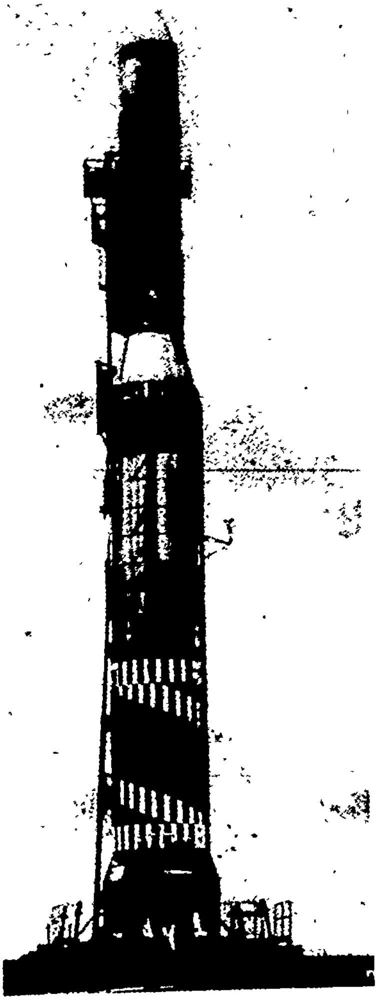

Figure 63. Diamant B.

Africa), Congo-Brazzaville, and South Africa. It is used to track all French national launches.

Although most other free world European nations have joined the United States in cooperative projects. France has entered into cooperation with the Soviet Union. Under the working agreement between the two countries, France has provided the scientific and technological satellite, **SRET**, which was launched concurrently with a Molniya shot 4 April 1972. In the past, the Oreol 1, launched 27 December 1971, and the laser reflector used on Lunokhod 1 were the results of Franco-Soviet cooperation.

Finally, the relative success of the French national program is evident in the percentage of successful French launches. In April 1971, a French D-2A satellite was launched to measure radiation. This was the seventh successful satellite launch in as many firings, making it the world's best "satellite batting average."

GERMANY.—West Germany has engaged in a number of cooperative space programs with the United States and with other nations. Programs conducted with the United States have included meteorological and communications satellites, ionospheric and radiation belt research, and sounding rockets. Currently, Germany and France are working together on the development of a communications satellite called **Symphonie**

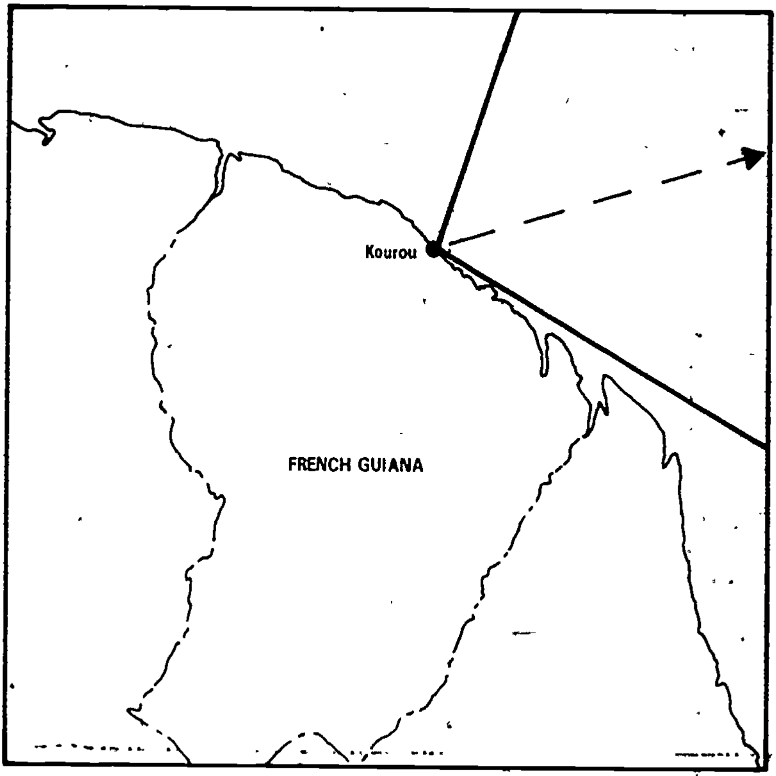

Figure 64. Kourou launch range.

which could form the basis of a European communications satellite network. If the Symphonie is successful, additional launches could establish a network of satellite communications that would free European countries from their dependence on INTELSAT. This development is very much in line with the resurgence of European nationalism.

The first German satellite was launched 8 November 1969, when a NASA Scout launch vehicle put **Azur** into orbit. This launch vehicle was followed by the Dial series launched by the French Diamant rocket. The most ambitious German project to date will be **Helios**. The Helios project is comprised of two solar investigation satellites to be put aloft by Atlas-Centaur

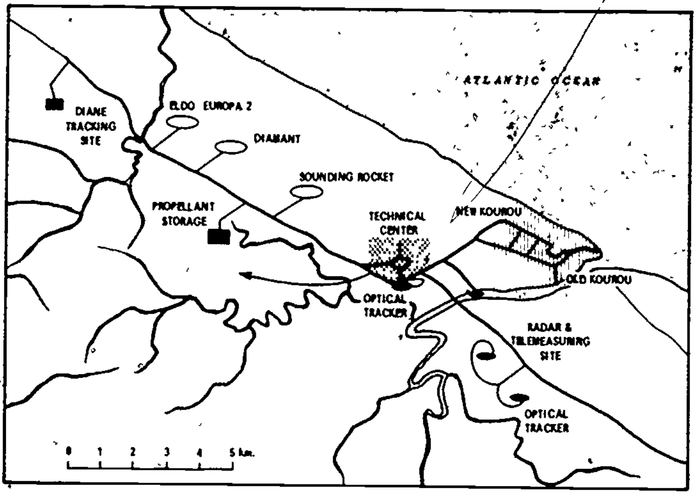

Figure 65. Kourou launch facilities.

rockets, 12 months apart, during 1974 and 1975. Helios will contain 10 experimental packages. These are designed to measure the speed of the solar wind, the mass and energy of interplanetary dust particles, and the interplanetary magnetic field and its various intensities. Helios will also monitor plasma and radio waves, identify cosmic radiation characteristics, chart solar electron energy distribution, and investigate zodiacal light (the glow in the west after twilight and in the east before dawn). Figure 66 shows a future West German scientific space probe.

Germany must depend on foreign launch vehicles to continue its satellite programs. Because of inadequate financial and geographic resources for launch vehicles and sites, Germany has not developed its own launch vehicle. However, it has joined the ELDO nations, and, as a result, it is in charge of building the third stage of the Europa launch vehicle.

THE NETHERLANDS.—According to NASA scheduling, the Netherlands will be the next new owner of an orbiting satellite, scheduled for launch in 1974. The Dutch satellite, ANS (**Astronomical Netherlands Satellite,** Fig. 67), will perform three experiments.

The first two experiments will involve highly complicated monitoring of x-rays. The third experiment will use an ultraviolet (UV) telescope to observe stars. The UV telescope experiment is particularly interesting because it will permit observation of blue-white, very hot, new stars. These stars are difficult to see from ground observatories because UV light is blocked by the atmosphere.

The Netherland's space effort has included research involving the measurement of soft solar x-rays, cosmic radiation, and wind movements in the ionosphere. In addition, the country's background in aerodynamics and avionics is being used in the testing of ELDOs rocket shapes and guidance. The Netherlands participates in a number of US and French cooperative programs as a leader in space electronics. In developing the ELDO Europa vehicle, the Dutch provided the telemetry equipment for the first and third stages of the Europa I and all three stages of Europa II.

OTHER NATIONS.—The programs of Spain, Poland, Rumania, Switzerland, Sweden, Austria, Belgium, Czechoslovakia, Denmark,

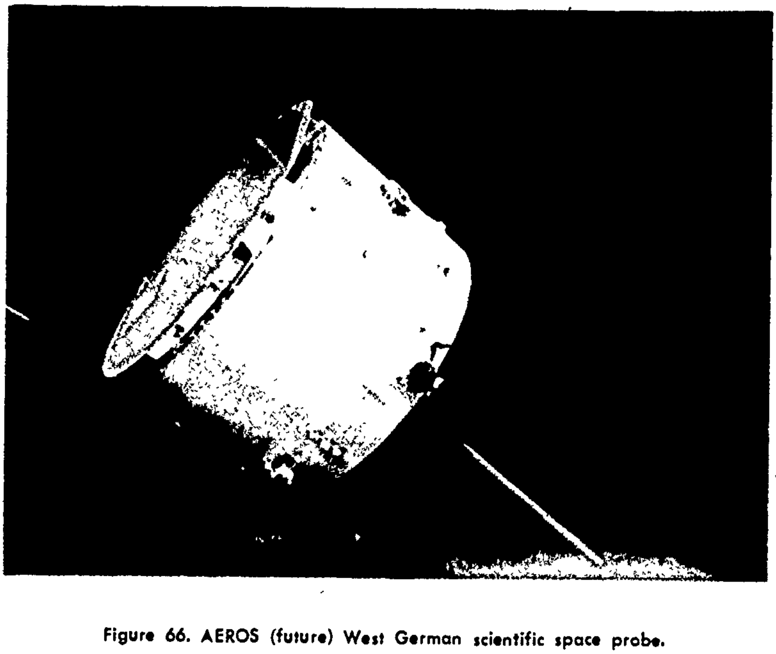

Figure 66. AEROS (future) West German scientific space probe.

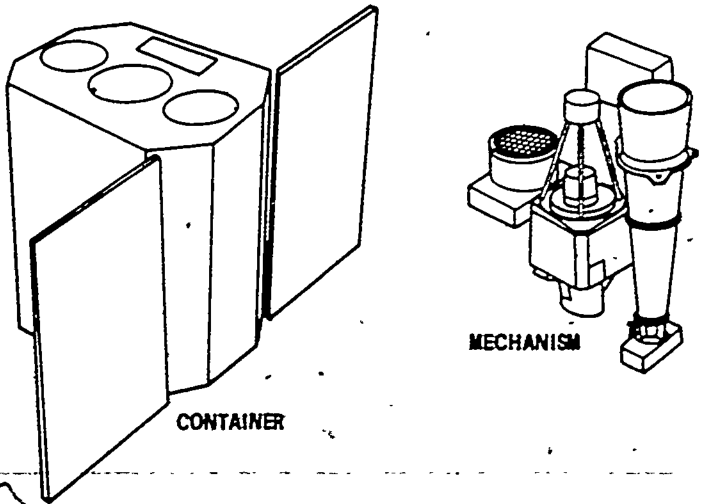

Figure 67. Astronomical Netherlands Satellite.

Hungary, and Norway should also be added to the list of national programs. These nations help support such varied activites as performing detailed experiments in aeromedical techniques and sounding rockets to supplying technicians to man tracking stations for the Soviet Union and the United States. Although most of these national efforts are relatively small, they are important to the nations involved and to the rest of the world. Regardless of who makes a breakthrough, all nations benefit because they do not need to repeat the expenses of discovery.

AMERICAS

The Americas are dominated by the US space program. As a result, there are no major international programs and few significant national programs. However, as in Europe, growth and national spirit have led to the beginning of such development There is a Pan-American organization called the **Inter-American Committee for Space Research** (IACSR) and another known as EXAMETNET, both of which are active in the Western Hemisphere Also, Canada, Brazil, Argentina, and Mexico are making definite moves toward the development of strong national programs

International Programs

IACSR.—The Inter-American Committee for Space Research was formed in 1960 to promote space research in the Latin American countries and to assist in the creation of national organizations to encourage and coordinate space-related activities in Latin America Although the United States participates in the committee's work, Argentina seems to furnish the drive for the group Under IACSR's auspices, several nations are cooperating in some limited space probes Special emphasis is given to experiments in which nations with limited resources can participate and receive the most benefit. The committee promotes joint experiments, personnel exchanges, and information.

EXAMETNET.—EXAMETNET is the **Inter-American Meteorological Sounding Rocket Network,** which studies weather conditions through the use of meteorological sounding rockets. Although the EXAMETNET program is modest, it is growing in size and importance. EXAMETNET has undertaken regular coordinated rocket soundings on a north-south line in the Western Hemisphere. Since EXAMETNET's formation in 1966, Argentina and Brazil have launched more than 100 rockets, synchronized (launched at the same time) with similar launchings from various US sites.

The Inter-American groups have met some success, but they have not been as influential as the European groups. There are logical reasons for this lack of influence. For example, the European nations are considerably more wealthy than the Latin American nations, and their industrial base is more highly developed. One needs only to compare France with Argentina, Germany with Brazil, or Great Britain with Bolivia to understand the reasons for this varying influence Although Latin American scientists have made some contributions to mankind's knowledge about space, the major strides in Inter-American space research have come as a result of bilateral projects involving the United States and individual Latin American nations.

National Programs

CANADA.—Canada has been actively engaged in space research for a number of years, and its fields of activity have been widespread Cooperation with the United States has been close and has resulted in the launch of the Canadian-built satellites aboard US boosters. Canadian space activities have reflected a long-standing interest in the communications problems of the polar ionosphere This has led Canada into joint satellite projects (three **Alouette** and an **ISIS** spacecraft launched between 1962 and 1969) to sound the ionosphere from above, these projects contributed substantially to US space objectives. Alouette 2, launched November 1965, continues to transmit usable data (Fig. 68). Another **International Satellite for Ionosphere Studies** (ISIS) was launched in 1971. Canada is developing a domestic communications satellite system for which NASA will provide launch services on a re-

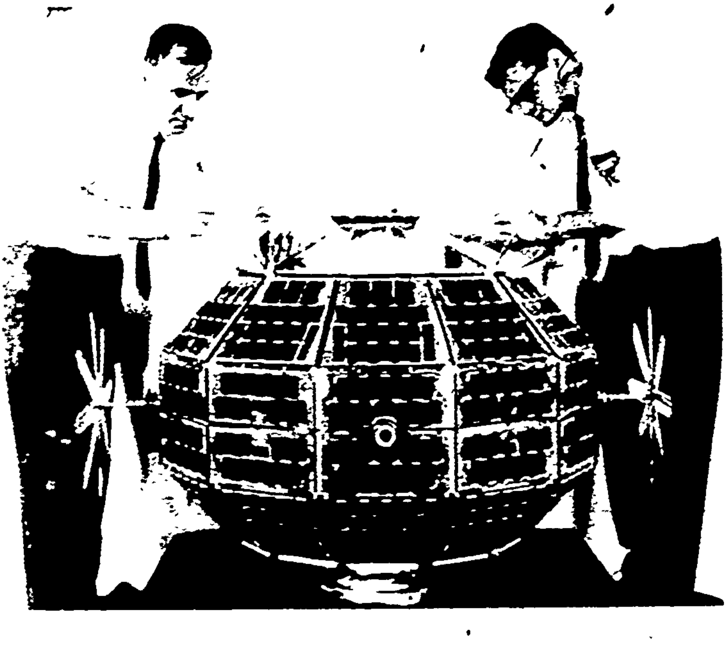

Figure 68. Scientists preparing Canadian built Alouette 11 satellite for launch

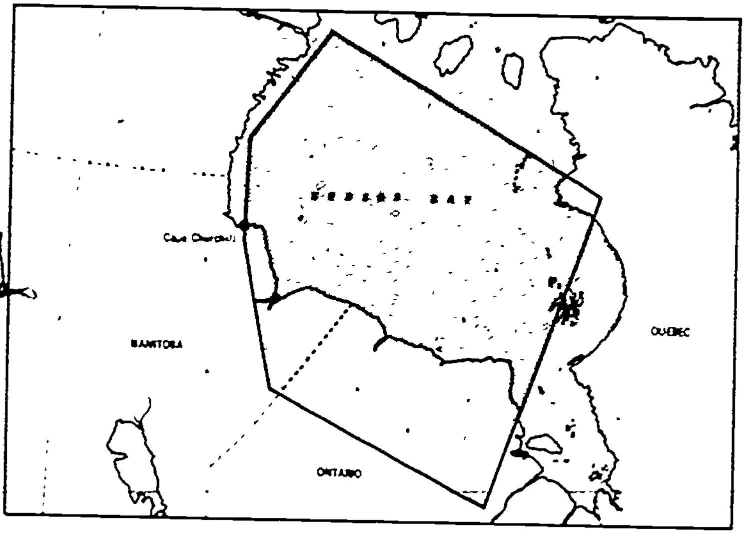

Figure 69. Churchill Test Range.

imbursable basis. For the future, Canada is studying a communications technology satellite, the objectives of which coincide very closely with those of the United States. The possibility of a joint effort is being explored.

Canada has an active sounding rocket program in operation utilizing the research range at Ft Churchill, Manitoba, on the west bank of Hudson Bay (Fig 69). The location of the **Churchill Rocket Research Range** makes it ideal for the study of auroral activity. The Canadian research programs also investigate engineering data, cosmic rays, the upper atmosphere, and a number of other subjects. Non-Canadian agencies, including NASA, have also used Canadian **Black Brant** solid-fueled sounding rockets.

BRAZIL.—Brazil has moved into the space age with a modest sounding rocket program, concentrating on ionospheric studies over the South Atlantic. Since this is an area of weak magnetic field intensity, it is an ideal area for the study of radiation. Brazil's location on the earth's equator enables it to manage the rocket studies and to launch satellites into equatorial orbits from its site at Natal. Since most applications satellites orbit the equator, nations lacking an equatorial launch range must use larger than normal rockets to launch and then maneuver their satellites into position. Brazil also conducts cooperative programs with NASA and with other Latin American nations, and it hopes to launch a communications satellite by 1973. Such a system would be used to aid in reducing the high illiteracy rate in remote parts of the jungle. Similar to the Indian program (see India), the Brazilian program will employ a US communications satellite and NASA launch services. By launching a geostationary satellite that hovers above the jungle, educational television could be broadcast over the area direct to battery-operated television sets. Such a system would aid in educating the bushmen and jungle warriors.

ARGENTINA.—Argentina is probably the leading Latin American nation in space research. It conducts an active sounding rocket program, chiefly involved with the study of weather and the ionosphere. Argentina has its own rocket range at Chamical (Fig 70), and it also engages in cooperative programs with NASA and EXAMETNET. International cooperation is a fundamental part of the program of Argentina's National Space Research Commission, and the country's rocket range is available for use by other nations. An Argentine proposal under consideration by the United Nations would establish an international range at Mar del Plata (Fig 71), on the east coast of South America.

MEXICO.—The Mexican space program is designed to make the most effective use of Mexican personnel and industry, even if this means performing some of the earlier experiments of other nations. Mexican authorities believe, however, that this approach will one day bring the Mexican program into prominence as a major contributor to space knowledge. A major project is that of informing the Mexican people of the need for space research The independent programs conducted by Mexico have included both sounding rocket and ground-based research Mexico cooperates with the United States on such programs as tracking of manned satellites, international fellowships, and visits to US facilities. The Mexicans have also built their own sounding rocket, the MITL.

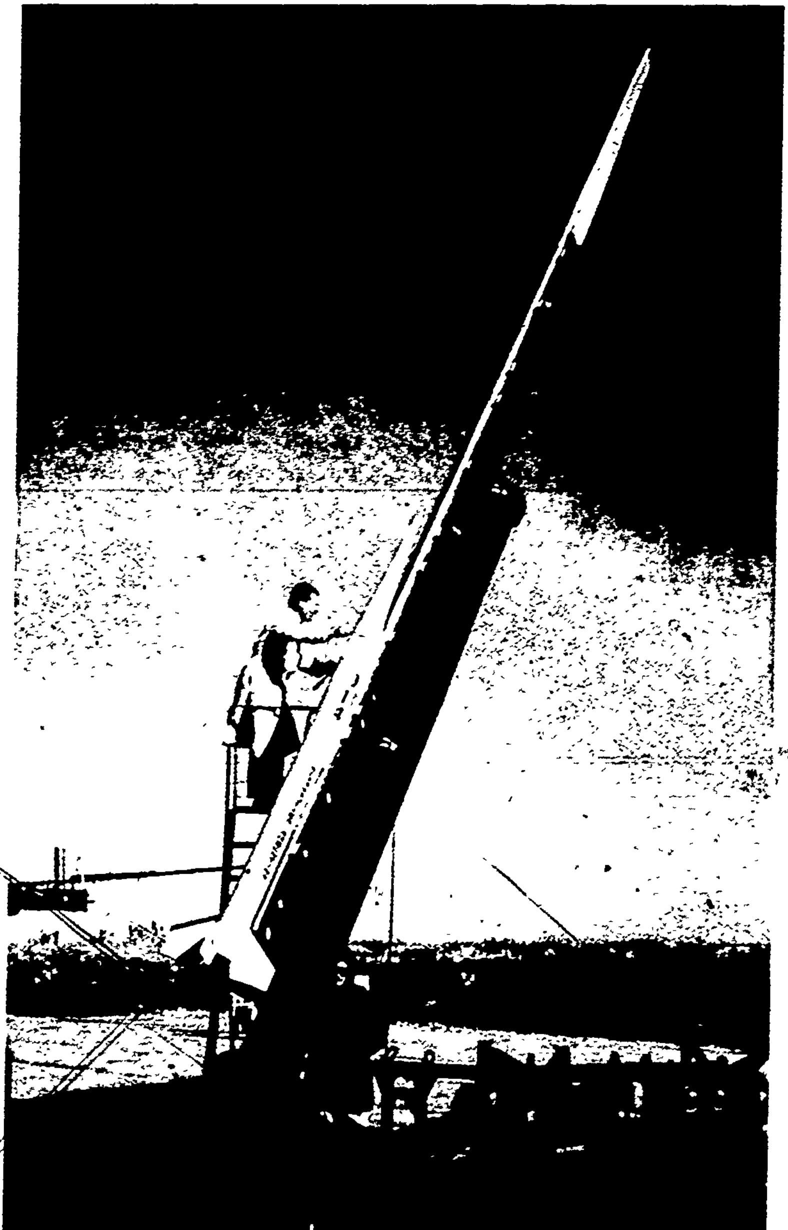

Figure 70. Argentine personnel check Argentina's Orion 11 sounding rocket at the Chamical test range.

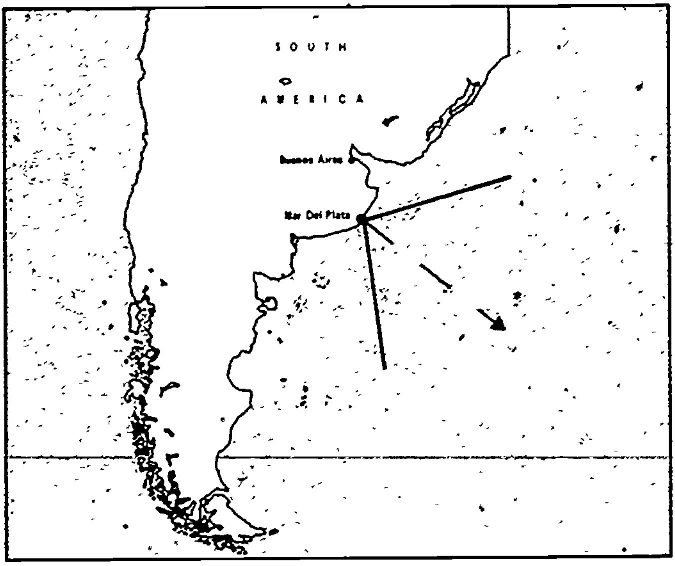

Figure 71. Mar Del Platta Range.

AUSTRALIA-ASIA SPACE PROGRAMS

The Australia-Asia area has no international programs of regional significance. The United States cooperates with many nations, but most of this cooperation is geared to a national program, either that of a recipient nation or a US program. However, some national programs in this area merit discussion, including those of two nations that have successfully launched their own satellites and one that has used NASA launch services to place a satellite in orbit.

Australia

In late 1967, Australia became the seventh nation to orbit a satellite, when **Weapons Research Establishment Satellite I** (WRESATI) was launched from Australia's Woomera (Fig. 72) test range, using a modified US Redstone rocket. Australia is engaged in many areas of space research and exploration including cooperative programs with several other nations. Its Woomera test range is an integral part of the ELDO program. Tracking stations in Australia keep a watch on manned and unmanned space shots and satellites put up by the United States. Australia has made valuable studies with sounding rockets in the area of upper atmospheric physics and has cooperated with Japan on ionospheric research. Australian scientists are considered pioneers in their radio studies of solar activity.

Japan

Japan has been involved in space research since 1955, beginning with a foot-long sounding rocket aptly named **Pencil.** Unfortunately, the combined restrictions of a moderate budget and prohibitions against such things as sophisticated guidance systems imposed by World War II surrender terms have slowed the progress of the program.

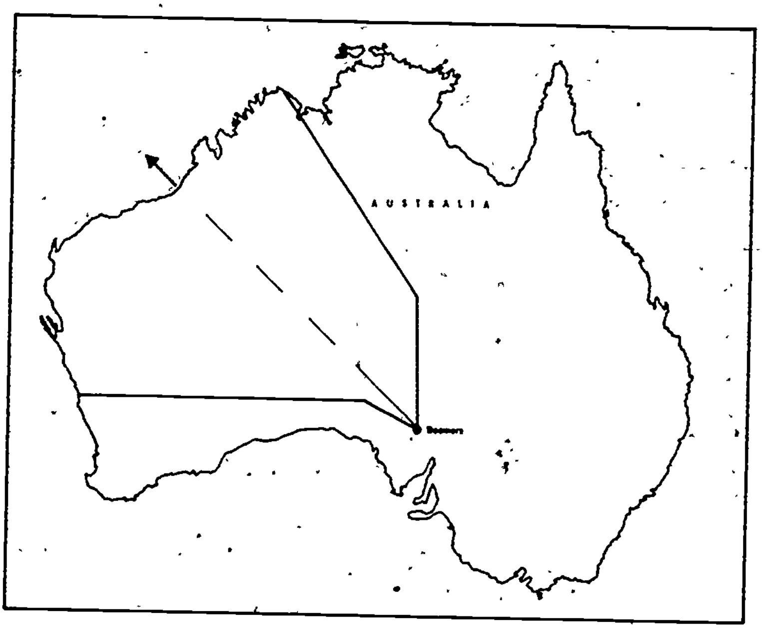

Figure 72. Woomera Range.

Japan finally succeeded in February 1970, when space officials placed the 50-pound **Osumi** (satellite) in orbit. Other satellite programs currently underway or planned for the future include the **Shinsei** (MS–F2) (Fig 73), and the **REX** (Fig 74). Eventually, the space program is expected to expand into more ambitious projects. For such programs, larger boosters like the Q and N boosters (Fig 75) will be employed.

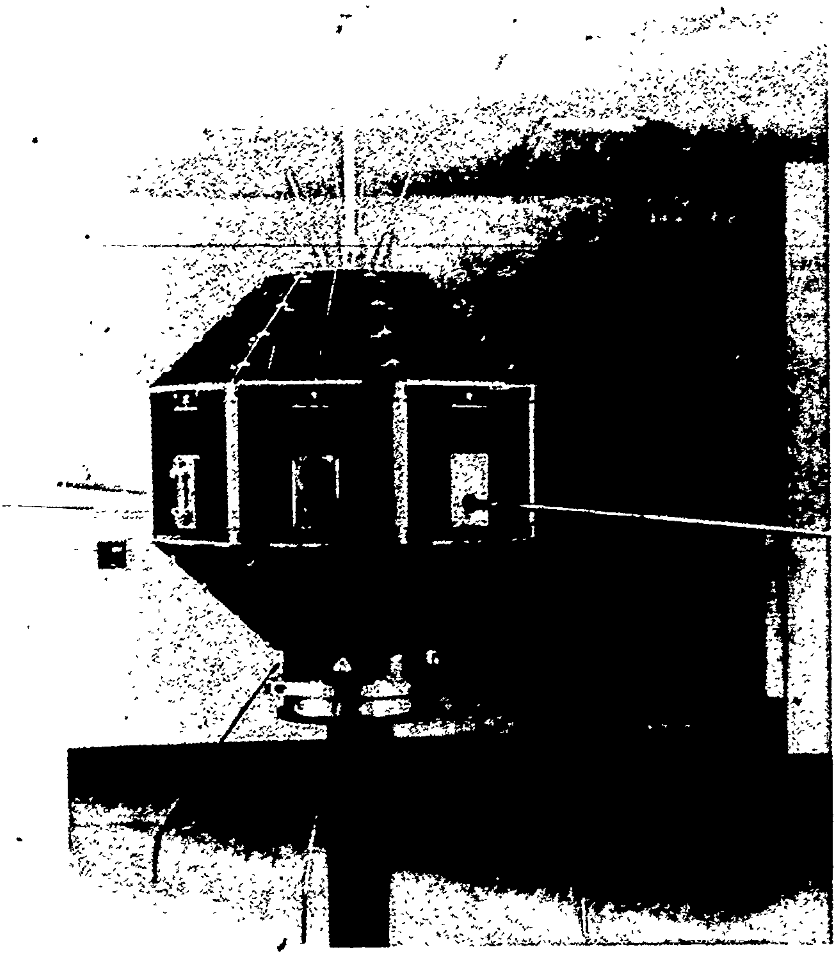

Figure 73. Shiusei, (MS–F2), Japanese scientific satellite.

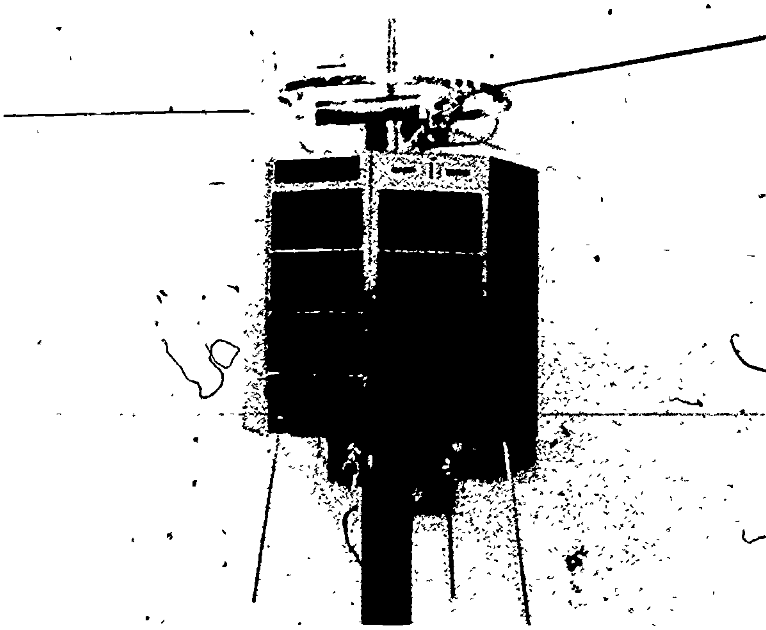

Figure 74. REX, (future), Japanese scientific satellite.

This sudden acceleration of the Japanese program is due in large part to economic growth and the healing of old war scars. One other development also has been very important. Originally, Japanese research was primarily a product of private enterprise, but, in 1960, the National Space Activities Council (NSAC) was formed as a Government advisory agency. It was replaced by the Space Activities Commission in 1968, which administers the program. Within a few years, the Commission created the National Space Development Agency (NSDA) to execute space activities. After these evolutionary administrative changes, Japanese space program plans were reorganized. First, as an economy move, internationally available technology would be used instead of independent national research. Second, the multivariety rocket program was abandoned in favor of the development of a single

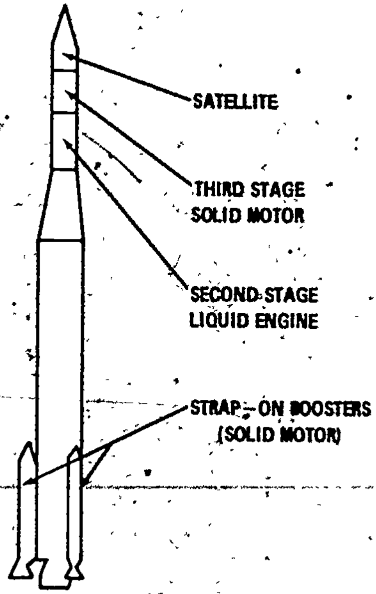

Figure 75. N booster.

rocket and launch facility by late 1973 or early 1974. (The Japanese have already completed the **Mu4s** and the **Kagoshima Launch Range** (Figs 76 and 77). Third, an aggressive satellite program, including meteorological, navigation, geodesic, communications, broadcasting, and earth resources satellites, was begun.

Mainland China

In April 1970, China launched a 380-pound satellite to become the fifth nation to launch its own satellite. **China-1** (designated "Chicom" by NORAD) broadcasted a Maoist song, "Tung Fang Hung," ("The East is Red") the Chinese version of "My Country Tis of Thee," back to earth.

Mainland China's first orbiting space satellite not only heralded that country's entry into the select group of space-age nations, but it raised the question of a Chinese intercontinental ballistic missile. Little is known about Chinese space sciences capabilities.

Apparently, the chief interest of other nations in the Chinese space program is its meaning in terms of ICBM capabilities.

Despite the appearance of a Chinese satellite, defense analysts view the development of a Chinese ICBM as lagging behind schedule. This assessment is based on four major observations.

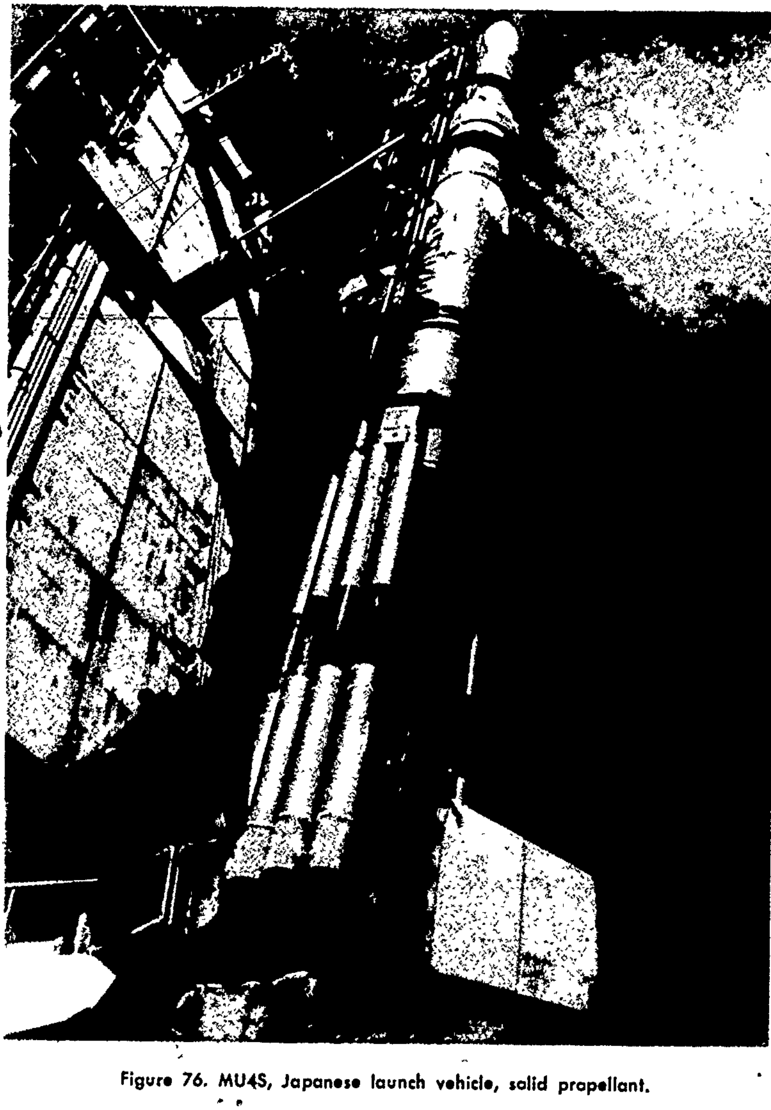

Figure 76. MU4S, Japanese launch vehicle, solid propellant.

First, since January 1967, US authorities have expected a demonstration of Chinese ICBM capability, either in the form of a satellite or ICBM test launch. Not only is proof of this capacity already overdue, but the most recent prediction is development by 1973, with a strong chance of another three years or more. Second, the satellites launched represented no improvement in vehicle development. They had the payload weight range of an MRBM, similar to those given to China by the Soviet Union in the late 1950s. Third, no Chinese tracking vessels have ever been sighted in the Pacific Ocean. Such vessels are a necessary component of an ICBM test flight. Finally, the Chinese have not demonstrated the technical competency in guidance systems necessary for ICBMs. The China 1 and 2 satellites did not have the highly sophisticated guidance systems expected in ICBMs.

It appears that the investment made in the satellite program was a trade-off from the ICBM development program. Such a trade-off would have to be based on political motives rather than on any tangible results from a satellite that has been called a

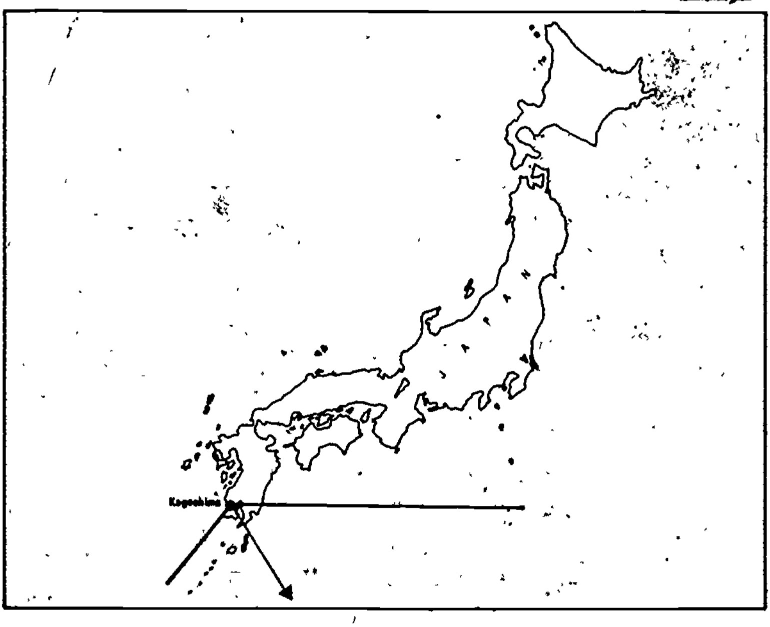

Figure 77. Kagoshima/Tanegashima Ranges.

"fairly primitive thing." However, there is another possible explanation for the Chinese switch from ICBMs to satellites. On the basis of China's past record of leap-frogging intermediate stages of development, some sources believe that China has bypassed ICBM development in favor of deploying orbital bombardment systems.

The final impact of Red China's entry into the space age will not be known for several years. As for the current state of Chinese development, it is technologically far behind and, to date, has not kept pace with world expectations.

India

India's future space plans center around development of a domestic communications satellite network and spacecraft launch capabilities. India has begun an instructional television experiment in conjunction with NASA to bring national educational programs to 5,000 remote villages on 23-inch receivers during 1973-74. This experiment will employ a NASA ATS-F (communications) satellite. Television programs will be beamed up to the satellite for rebroadcasting to the ground stations. The television receiver's antennas will be constructed of chicken wire shaped into a large bowl. Similar to the program pursued in Brazil (see Brazil), the Indian project will feature educational TV designed to help improve literacy, family planning, agricultural productivity, and national integration of the country's several hundred recognized languages. With this method, the objective of the program will be accomplished three times faster and at half the cost of conventional programs.

In addition to developing communications satellite systems, India is involved in a number of other areas of space exploration. India's competence in space science and technology has grown in large part through collaboration with NASA in scientific sounding rocket investigations. Also, since 1965, India operates a UN sounding rocket range at Thumba (Fig 78). Currently, India is building a new launch range approximately 50 miles from Madras, on the east coast of the southern tip of the country.

India now builds sounding rockets under license to Sud Aviation and has developed a small rocket capacity. The Indians

Figure 78. Indian crew prepares to launch Apache rocket from Equatorial Sounding Rocket Range at Thumba, India.

plan to scale these projects up to a satellite-launch capability. Present Indian launch plans should be completed by 1975.

Other Nations

Aside from the relatively larger national programs already mentioned, Iran, Israel, and Pakistan are also involved in multi-goal programs on a much less ambitious scale. Their programs are tuned more toward performing a service (NASA observers) or seeking immediate application of space technology to their limited economies.

IRAN.—Iran participates in NASA programs, including the resident associate program at US universities and the program of personnel exchange. It is engaged in studies of cosmic radiation and meteorology and sunspot phenomena. Iran's location on a high plateau in the Middle East affords excellent height and visibility and makes the country an ideal location for future development or space research programs. Steady economic and social progress promises the fulfillment of Iran's potential in space research.

ISRAEL.—With its highly trained scientists and technicians, Israel applies space knowledge to its efforts to make its desert environment more livable. It has used sounding rockets to study temperatures, pressures, wind currents, and other aspects of the upper atmosphere. Israeli scientists have conducted extensive studies in space matters related to metallurgy, propellants, and shock waves as they seek ways of controlling the environment at the lowest possible cost. Israel cooperates with NASA's ground-based projects for ionospheric study, resident research associateships, and personnel exchanges. Outstanding cooperation between Israel and the United States has taken place in the use of meteorological satellites.

PAKISTAN.—The Pakistani space effort is concentrated in two areas First, meteorological sounding rockets are being used in joint rocket launches with NASA. Second, the development of space technologies that can be directly applied to relieve poverty in the country through cooperative agreements with France, Japan, the United Kingdom, and the United States in the training of Pakistani scientists and technicians.

THE UNITED NATIONS: WORLD SPACE FORUM

Since its founding in 1945, the United Nations has served as a forum for the discussion of numerous subjects affecting the welfare of the world. Although the power behind UN resolutions is limited to the power of world opinion, the UN has not been without influence. It is the most logical organization through which international efforts in space can be coordinated, and, although most information comes through exchanges on a nation-to-nation basis, much of the world's formal interchanges involving several nations occur through the United Nations.

The General Assembly

The UN General Assembly is a body in which all member nations are represented and in which each has a voice. The General Assembly functions as a forum for debate on international issues. It is the parent of the United Nations' Committee on the Peaceful Uses of Outer Space, which serves as a sort of technical advisor to the UN on space matters.

One of the more important contributions made by the General Assembly was the establishment of the **United Nations Space Registry** (UNSR). The registry lists the international designation, name of the launch vehicle, category of the satellite or space probe, date of launching, inclination, period, and apogee and perigee It lists shots into orbit and beyond. The Registry is constantly changing because of additions, subtractions, and modifications of space vehicles. Since March 1962, the United States and the Soviet Union have supplied information to the United Nations Space Registry. Other nations have filed similar information with the UNSR as they have developed launch capability.

The registry provides scientists of all nations with an up-to-date inventory of orbiting objects and space probes. It encourages cooperation among nations engaged in space research. It enables space researchers to know the identity of each space vehicle, and, one day, it may be used to determine which of the "dead" spacecraft can be eliminated if near space becomes so cluttered that "housekeeping" in space becomes necessary. Indeed, such an operation may become necessary; as of 4 Oct 1972, 6,211 satellites had followed Sputnik 1, and 2,851 assorted objects were still in orbit.

The Space Committee

The **United Nations Committee on the Peaceful Uses of Outer Space** is the only internationally-sanctioned governmental body dealing with the legal and political aspects of space. Although the committee's actions have no binding authority, they are usually accepted by the General Assembly. Thus, world opinion is thought to be an important force behind the committee's recommendations.

The Committee on the Peaceful Uses of Outer Space is composed of diplomats, not scientists. Therefore, it serves not to produce new information but to channel information from the various international scientific organizations, to coordinate international space policy, and to encourage international agreements, national programs, and cooperative ventures that will benefit the world.

Some major recommendations made by the committee and accepted by the General Assembly include the establishment of an international launch facility (at Thumba, India) for sounding rockets, sponsored by the UN and available to all of its members; the compilation and organization of information by the UN regarding space probes, and the coordination of efforts between UN officials and international scientific organizations.

The World Meteorological Organization

The **World Meteorological Organization** (WMO) became a specialized agency of the United Nations in 1951. Its major function is to promote international cooperation in weather observation to improve weather services. This function has brought the creation of a worldwide network of weather stations. This network of stations will eventually enable national weather services to use pictures that depict weather conditions throughout the world.

The coming of the space age brought important changes in the field of meteorology. Entirely new techniques became possible. For example, the ability to photograph the earth from an orbiting satellite meant that storms could be located and traced from their birth even though they were far away from conventional observation stations. It became possible to draw a world weather map with much greater speed, accuracy, detail, and coverage than ever before.

The change in this science was so great and its value so immediate that weather services were among the first to make practical use of space technology. To the World Meteorological Organization went the task of applying this new technology to its previous function and of contributing to the meteorological aspects of future man-made satellites.

Space activites have become a vital part of the WMO operation, the **World Weather Watch,** which operates on the basis of four-year phases, the first beginning in 1968. The current phase, 1972-1975, is concentrating on filling the gaps in needed coverage The Global Observation System urgently needs additional surface and upper air observation stations in the tropics, the Southern Hemisphere, and the ocean areas of the Northern Hemisphere. The ocean areas are the most critical, but, even in overland areas, significant gaps exist in certain portions of Brazil, in the desert regions of North Africa and Southeast Asia, and in parts of the South Pacific. When the current goals are completed, every nation of the world will have improved weather information and forecasting. For many years, weather has been the enemy of underdeveloped countries and industrial nations, today, the United Nations, through international cooperation, is seeking a solution to the problem. When the World Weather Watch is completely operational, perhaps such tragedies as that which occurred in Bangladesh will be significantly reduced.

CONCLUSION

The most important point to remember in this chapter is that space exploration is truly international, with over 80 percent of the nations of the world participating in some way. Many nations have felt the combined urges of exploration and national pride and launched their own programs. At the same time, groups of nations have worked together to cut costs and share information; the three most significant examples are ELDO, ESRO, and the UN. Such programs have led to international satellite activity, resulting in British, Canadian, French, Australian, Italian, German, Japanese, Chinese, ESRO, and NATO satellites in orbit with those of the United States and the Soviet Union. And most importantly, the benefits of space exploration have been brought to the common people through such cooperative programs as educational television by satellite (Brazil and India) and the World Weather Watch (UN).

WORDS, PHRASES, AND NAMES TO REMEMBER

European Space Research Organization (ESRO)
European Launcher Development Organization (ELDO)
HEOS

European Conference for Telecommunications by Satellite (CETS)
Committee for European Space Research (EUROSPACE)
International Aeronautical Federation
Ariel
Skynet
X-3
Black Arrow
Jodrell Bank Radio Telescope
San Marco
Satto di Quirra
GHz
Small Astronomy Satellite (SAS-A)
SIRIO
Diamant (dyah-MAWN)
Europa
Coralie (ko-rah-LEE)
Dial
Peole (pay-OHL)
Guina Space Center
SRET
Symphonie
Azur
Helios
Astronomical Netherlands Satellite (ANS)
Inter-American Committee for Space Research (IACSR)
Inter-American Meteorological Sounding Rocket Network
Alouette (ahl-WET)
Isis
International Satellite for Ionosphere Studies
Churchill Rocket Research Range
Black Brant
Mar del Plata (mar-thel PLAH-tah)
Weapons Research Establishment Satellite (WRESAT)
Pencil
Osumi (oh-SOO-me)
Shinsei (SHIN-say)
REX
Mu4s
Kagoshima Launch Range (kah-go-SHEE-mah)

China 1
United Nations Space Registry (UNSR)
United Nations Committee on the Peaceful Uses of Outer Space
World Meteorological Organization (WMO)
World Weather Watch

QUESTIONS

1. ELDO and ESRO are two important organizations involved with international cooperation in space. What do these acronyms stand for and what are the functions of these organizations?
2. What European nations already have a satellite in orbit?
3. Name two international programs located in the Western Hemisphere.
4. What American nations, besides the United States, are actively involved in significant space efforts?
5. What Australia-Asian nations have satellites in orbit.
6. Name any three satellites, other than US or Soviet satellites, and designate the nation that owns them.
7. List three major contributions to international space cooperation made by the United Nations.
8. What is the WMO and what major worldwide program does it operate?

THINGS TO DO

1. In view of the questionable status of both ESRO and ELDO in a changing Europe, give a report on the current status of these organizations Be sure to include such information as projects, budget, membership, and any highly successful ventures.
2. To keep up with the advances of smaller nations, write to their embassies for current information. Do not stop with the nations listed in this chapter; also consult any nation that you feel has the necessary technology to attempt space exploration. A list of embassy addresses should be available from the almanac.
3. To understand the unique problem of Japan in developing a guidance system under post-World War II restrictions, report on gyroscopic stabilization. This can be done by demonstrating and explaining the functions of a simple gyroscope and then relating the principle to a spinning satellite Keep in mind that the satellite spun on an axis that was parallel to the earth's surface.

SUGGESTIONS FOR FURTHER READING

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Office of International Affairs. *International Space Programs.* National Aeronautics and Space Administration, Jan 1971.

U S, Congress, House, Committee on Science and Astronautics, Subcommittee on International Cooperation in Science and Space, *A General Review of International Cooperation in Science and Space,* 92nd Cong. 1st sess. 1971.

"China Joins the Space Age," *Science News,* 2 May 1970.

Space Law

THIS CHAPTER deals with the legal aspects of space exploration. It is designed to highlight the legal issues and space treaties as they exist today and offer a limited amount of insight into their importance and development. After completing this chapter you should be able to: (1) explain the difference and interrelation between jurisdiction and sovereignty, (2) discuss the theories of demarcation, (3) name the sources of law, (4) list the two major space treaties, (5) discuss the "balance" of the Space Treaty, (6) understand the status of international liability in space, (7) explain how the jurisdiction/sovereignty issue relates to defining "Outer Space," and (8) identify some of tomorrow's questions about space.

When the Wright brothers began the conquest of vertical space at Kitty Hawk, North Carolina, decades before the first Sputnik, they began the creation of space law. As the decades passed, the world progressed from free air space to national air laws and, finally, to international air laws. Although many international agreements were made, the one which had the greatest impact on space law was signed at the 1944 **Chicago Convention** (Fig 79). Under this agreement, nation states were given unlimited sovereignty over the aerospace above their territory and each country was given the jurisdiction to enforce law within its territory.

Influenced by this belief in total sovereignty, some Americans wanted to shoot down the Russian Sputnik, claiming a violation

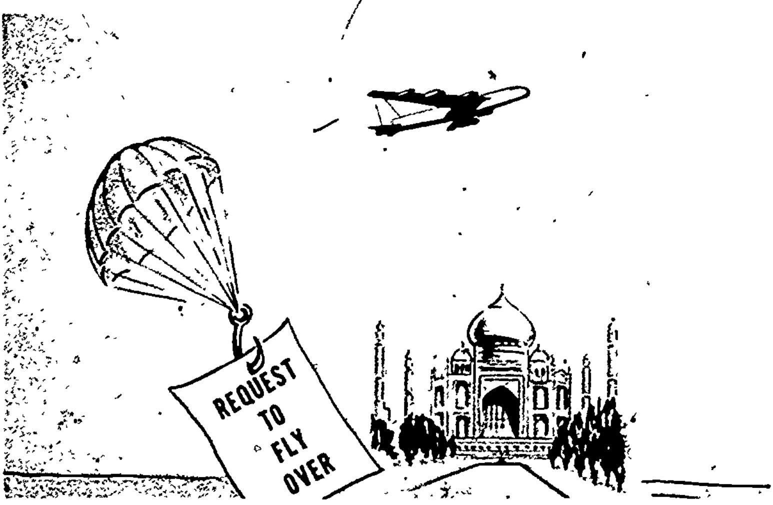


Figure 79. Under the concept of total sovereignty, from the Chicago Convention Agreement, nations have to request permission to fly over national territory.

of international law. In this case, the Sputnik was a legal act, not a violation of international law. However, it was legal only because in 1955 an international agreement had proclaimed 1957–1958 the first International Geophysical Year (IGY) and made satellites legal during that period. The legality of satellites launched after 1958 and the jurisdictional authority to declare them legal are still an open question.

JURISDICTION AND SOVEREIGNTY

The issue of jurisdiction and sovereignty covers much more than whose sky is being used. It also deals with ownership of space vehicles, authority to make laws governing human and national activity, and courts that can punish offenders. **Jurisdiction,** the power and authority to interpret and apply law, and **sovereignty,** freedom from external control, are extremely important to international space law.

The interaction of jurisdiction and sovereignty has been a major source of conflict. Without power of jurisdiction, no country could ever punish a lawbreaker, regardless of how many people agreed that the law had been violated. Laws are meaningless unless someone has the power to enforce them. Consequently, at the national level, proper jurisdiction is essential to national sovereignty. There appears to be an insoluble conflict, however, between national sovereignty and international jurisdiction. Jurisdiction is necessary for sovereignty at the national level; a reduction in sovereignty is necessary for jurisdiction at the international level. For example, if the UN was given jurisdiction over military operations in aerospace, it would not only protect countries from each other but would control what each country did above its own territory.

How can law and order be established in space until this issue is resolved? If those who offend sovereignty cannot be punished because no one has the necessary jurisdiction, then there is no sovereignty. However, if jurisdictional control is surrendered to someone else, there still is no sovereignty. A solution, of course, would be for nations to forget about national sovereignty and invest jurisdictional control in a set of rules to protect everyone, such as a treaty to submit to the rulings of the International Court. Another cure would be world government. To do the latter nation-states would have to agree on the form of government used to administer the rules. Some would consent to nothing but a republic, like the United States; others would have only a socialist government, like the Soviet Union. Obviously, a world state today is beyond the realm of practicality in the affairs of nation states.

To date, we have attempted to bridge these gaps with a patchwork system of treaties, international agreements, discussions, and arbitrary limits to sovereignty (called **lines of demarcation**): a little sovereignty is surrendered for a little cooperation. Until the more basic ideologies (beliefs) of nations are made compatible, jurisdiction will probably remain the key to future developments in space law.

Theories of Demarcation

After the launch of Sputnik I, nations were so concerned about proving that there had been a violation of national sovereignty that they retreated to the ancient Roman law, *Usque ad Coelum* (up to the heavens). Under this ancient law a man owned everything about his land up to the heavens (Fig 80). Now that an

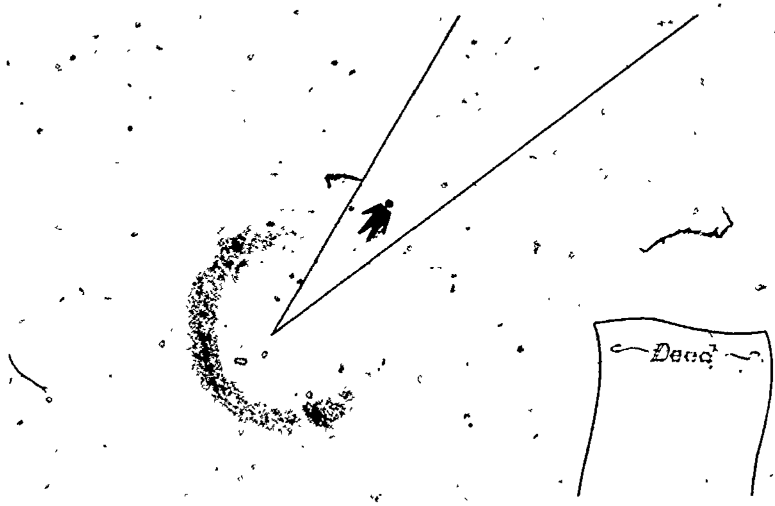


Figure 80. Usque and Coelum—up to the heavens.

established precedent had been found, the only remaining problem was to determine where sovereignty ended and heaven began. The following are examples of some of the current theories.

Gravitation Theory.—The Gravitation Theory, also known as the Kroell-Rink Theory, links sovereignty to the outer limits of the earth's gravitational pull. Professor Rink estimates such a boundary as being 1.5 million km (900,000 miles) above the earth's surface. This would mean not only that all satellites are in violation of national sovereignty but that the ownership of the moon changes hands constantly as it passes over the territory of first one nation and then another.

Airspace Theory.—Under the Airspace Theory, the outer limits of sovereignty and atmosphere are the same. Since this is much more sensible than the gravitation theory, it has received more consideration. However, there is one major difficulty in the theory. It is extremely difficult to establish clearly the end of the atmosphere. In attempting to do this, three different subtheories have been developed.

(1) **Atmosphere Theory:** Under this theory, sovereignty ends when there is no longer any atmosphere present. Though still difficult to judge clearly, it would be easier than attempting to

determine what concentration of molecules constituted atmosphere and what did not, as the general airspace theory implies would be necessary.

(2) **Aerodynamic Theory:** This theory is based on atmospheric properties rather than atmospheric presence. The lower layers of the atmosphere provide the aerodynamic lift necessary for the flight of aircraft and for the action of the internal combustion engine. Thus, that point where aircraft can no longer fly because of a lack of aerodynamic lift marks the beginning of free space. There is an understood agreement among the great powers that outer space begins where vehicles no longer get any support from the air (60 miles or 100 km). For example, US pilots are awarded astronauts wings for sustained flight above 50 miles (AFM 35-13).

(3) **Biological Theory:** Primarily the work of LeGoff in 1934, the biological theory is a definition of atmosphere based on human life. Since atmosphere comes from the Greek word "atmos," which means "breath," only the layer of air that sustains life by breathing is properly labeled atmosphere. This would mean that the "air" surrounding mountain tops higher than approximately 10 miles would be in free space and outside of national jurisdiction.

Theory of satellite orbit.—Akin to the atmosphere theory is the concept that the boundary of state sovereignty should be drawn at the lowest level at which a satellite can be put into orbit. Theoretically, it should be possible to orbit a satellite near the beginning of the atmosphere, providing the satellite has enough speed. The lowest level of orbital injection attained thus far has been 140 km (US Mercury, Friendship 7).

The von Karman Line.—The von Karman Line is very similar to both the aerodynamic theory and the theory of satellite orbit, although much more technical (Fig 81). Compared to the aerodynamic and satellite orbit theories, it is mathematically explicit. The line is drawn under the following conditions.

- Air and space travel depend, among other things, on aerodynamic lift and centrifugal force, respectively.
- There is a point where centrifugal force takes over and the aerodynamic lift is gone.
- This point, approximately 83 km or 275,000 feet, is the von Karman line.

VON KARMAN LINE

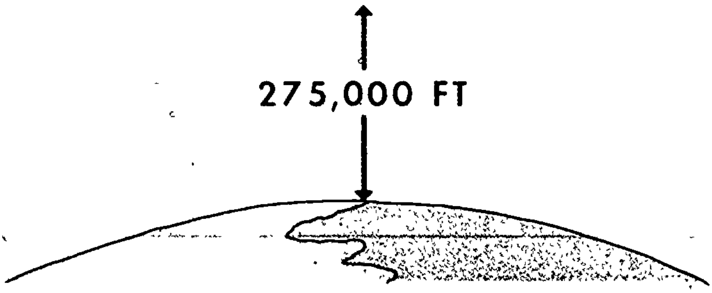


Figure 81. The Von Karman Line. This theory of demarcation has wide international support.

Theory of effective control.—This theory proposes that a nation has the right to claim sovereignty over whatever it has the power to control effectively. For our purposes, effective control would mean the power to prevent unauthorized flights. Under this concept, the previously discussed intercept and destruct satellites of the Soviet Union could mean unlimited sovereignty for the Soviets, while nations like Switzerland, Thailand, and Bolivia would have limited sovereignty. Such a system would not only be unfair, but it would increase world tension and confrontations and be highly variable with changing weapons and space programs.

Interest Theory.—In a more idealistic realm lies the interest theory. This is based on the presumption that a nation's sovereignty extends as far as its national interest. Likewise, a nation has no right to halt or protest activities within its jurisdiction that do not affect its national interest. Unfortunately, such a concept not only fails to make a clear division between air space and outer space, but it motivates one-sided decisions by nation-states, in the absence of an international agreement.

Security Theory.—Although security should play an important role in choosing a method of demarcation, it provides at best a poor method in and of itself. Different nations have different security problems, at different times, and in different areas, all of which are subject to rapid change and one-sided decision making. Security should be a by-product of an effective line of demarcation, but security alone is incapable of providing a reasonable division.

Current Status

To date, no single system of demarcation has emerged as a chosen international standard (Fig 82). However, this does not mean that the field has not been narrowed, nor does it imply that there are no favorite theories. The theories of gravitation, effective control, interest, biological atmosphere, and security have all been discarded because they are either impossible to administer or unrealistic in their scope, or both. The theory of satellite orbit has been blocked by a failure to define a satellite. This

Figure 82. Many theories have been proposed for a demarcation line between aerospace and outer space. No universal standard has yet been agreed upon by the nations of the world.

leaves only the atmosphere, aerodynamic, and von Karman Line theories. Since all three theories are interrelated and overlapping, a case cannot be made for any one to the exclusion of the other two. The von Karman Line, however, probably has the greatest international support because it is definite in its formula and is based on acceptable principles and analysis. Still, there is no universal standard, and there probably will not be one for quite some time.

PROGRESS AND PROMISE

This section deals with four areas: the rules of space today; (2) law by treaty; (3) current questions; and (4) future questions.

The Rules of Space Today

Space is a medium in which many activities may take place. Space is free for general use, as are the high seas, and the mere use of the medium is not prohibited. On the high seas, ships of war, as well as merchant ships, are permitted to move freely in innocent passage without violating peaceful behavior. As we shall see, in space, certain prohibitions have been added. Space shall not be used to orbit weapons of mass destruction, with the exception that armed ICBMs can pass through space. Likewise, it is not permissible to conduct military operations on other celestial bodies.

Law by Treaty

At the international level, there are two sources of law: custom and treaty. From Sputnik (1957) to the **Treaty on Outer Space** (1967), custom was the only source of active law relating to space. This does not mean, however, that progress was not being made toward the formulation of laws and agreements. The more notable actions preceding 1967 were the Atlantic Treaty of 1959, the United Nations Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, adopted by the General Assembly in 1963, and the resolution adopted by the General Assembly in 1963 that calls upon states not to station weapons of mass destruction in space, whether in orbit around the earth, on celestial bodies, or otherwise All that these declarations of principles accomplished was a stating of world reaction to satellites. Custom remained the source of space law.

Finally, in 1967, the universal rule of custom was changed by the signing of the Outer Space Treaty. Despite President Lyndon Johnson's assessment, "The Treaty is an outstanding example of how the law and political arrangements can keep pace with science and technology," it had taken nearly a decade for law and political arrangements to catch up with just a few of the questions raised by Sputnik 1. Despite its late appearance, the Outer Space Treaty proved to be a well-balanced and complete international agreement.

Establishing a balance between rights and obligations was of particular concern to the treaty negotiators. It was recognized that, while only a limited number of states might enter outer space, such activities could affect the well being of everyone on this planet and in the earth's environment. Further, it was recognized that, when man extends his activites beyond the earth, he ought to do so as more than just the representative of a single nation state. Thus, the treaty speaks of astronauts as "envoys of mankind" (Article V) and considers the exploration and use of celestial bodies to be for the benefit of all mankind (Article I). Knowledge derived from space will be made available to scientists of all nations (Article XI). The importance of avoiding harmful contamination of the earth as well as of celestial bodies is dealt with in the treaty (Article IX). The provisions of liability (Article VII), interference with other countries' space activities (Article XII) and assistance to and return of astronauts (Article V) are part of the balance of rights and obligations that are characteristic of any successful negotiating effort.

The treaty is also balanced between principles having immediate application and others whose usefulness will be proven in future years Among the principles of immediate importance are the provisions on liability, the obligation unconditionally to assist and return astronauts, and the obligation to report any findings that bear on the safety of astronauts (Article V, Fig. 83). These can be of direct importance in the carrying forward of national space programs Among the broad principles that will grow in signifi-

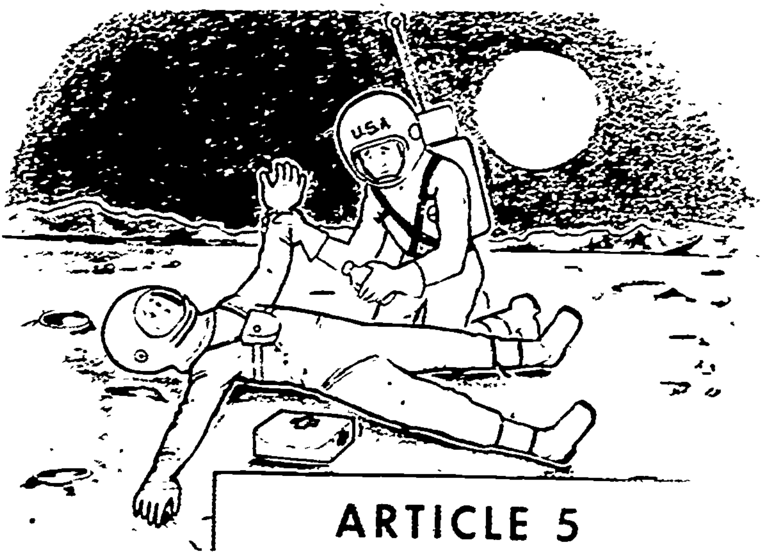


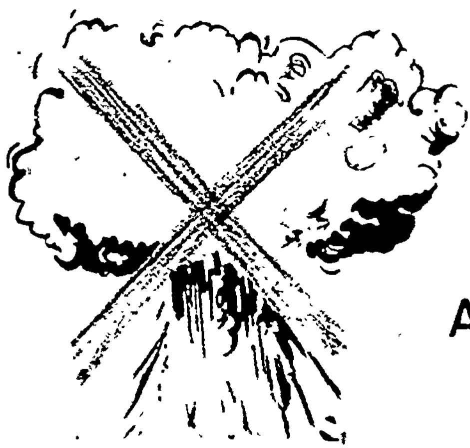
Figure 83. In cases of accident or emergency astronauts shall render all possible assistance to astronauts of another party to the treaty (see Appendix C, Article V, Outer Space Treaty, 1967.)

cance are those applying international law and the United Nations Charter to the activities of states in outer space (Article III), insuring freedom of exploration (Article I), and barring national appropriation of outer space and celestial bodies (Article II).

Finally, the treaty's arms-control provisions (Article IV, Fig. 84) are of immediate and particular importance to every nation's security. Parties to the treaty agree not to place in orbit around the earth any objects carrying nuclear weapons or any other kind of weapons of mass destruction, nor to install such weapons on celestial bodies, nor to station such weapons in outer space in any other manner. Parties to the treaty will use the moon and other celestial bodies exclusively for peaceful purposes. They will not establish military bases, installations, or fortifications and will abstain from testing any types of weapons or conducting military maneuvers on celestial bodies. There is, of course, no prohibition on the use of military personnel and equipment for peaceful scientific purposes.

To supplement these arms control measures, the treaty contains provisions which, together with developing national capabilities, will permit adequate verification that the treaty is being observed. Article I permits free access to all areas of celestial bodies. Article XII (Fig. 85) provides that all stations, installations, equipment, and space vehicles on the moon and other celestial bodies shall be open to representatives of other parties to the treaty. In addition, outer space and celestial bodies are declared free for exploration and use by all states and the treaty provides that outer space is not subject to national appropriation. The problems of military security, which are related to this treaty, have been examined with great care. The conclusion of various governments' agencies, including those with special responsibility for military and defense matters, is that the treaty will contribute to world security.

In conclusion, this treaty is not complete in all possible details. It does not deal with all problems that may develop. But it is responsive to those problems that can be described and forecast today. Furthermore, the Outer Space Treaty established the basis for a legal body to govern the activities of states in outer space (Article III). See Appendix C for a copy of the 1967 Outer Space Treaty.



ARTICLE IV

Figure 84. The moon and other celestial bodies are to be used exclusively for peaceful purposes (see Appendix C, Article IV, Outer Space Treaty, 1967).

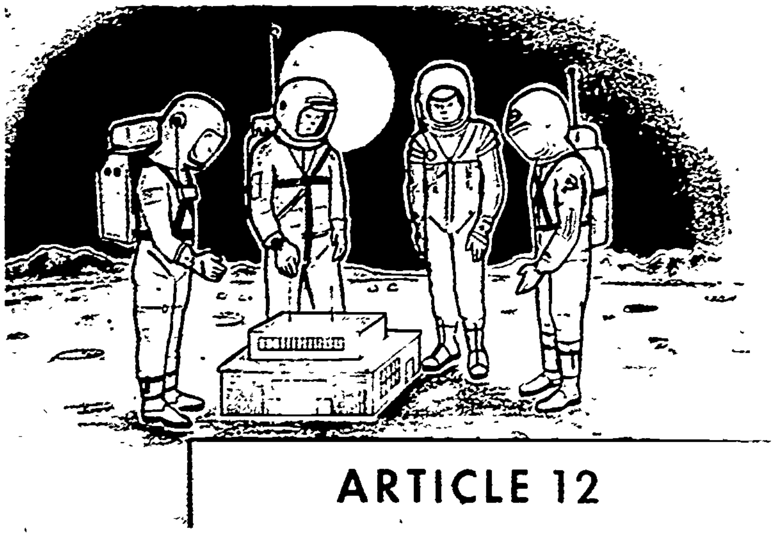


Figure 85. All activities on the moon and other celestial bodies shall be open to representatives of other parties to the treaty (see Appendix C, Article XII, Outer Space Treaty, 1967).

The most recent treaty action has been the **Rescue and Return Agreement** (1968). Under this agreement Articles V and VII are removed from the Outer Space Treaty and expanded to fill loopholes that developed in the provisions covering rescue and return of astronauts and space equipment. The Rescue and Return Agreement was necessary to define the meaning of "envoys of mankind." In the original treaty, astronauts were called envoys of mankind who would be unconditionally returned to their countries when recovered. Under the 1968 agreement, all parties to the treaty were made responsible for the immediate assistance and recovery of astronauts in trouble (Fig. 86). Further, all parties were responsible for the *prompt* and unconditional return of astronauts (Fig. 87). Similar expansion was also accorded to provisions on ownership of equipment recovered from space. The Outer Space Treaty had assured the launching nation ownership, while the 1968 agreement assured the return of such property. See Appendix D for a copy of the 1968 Rescue and Return Agreement.

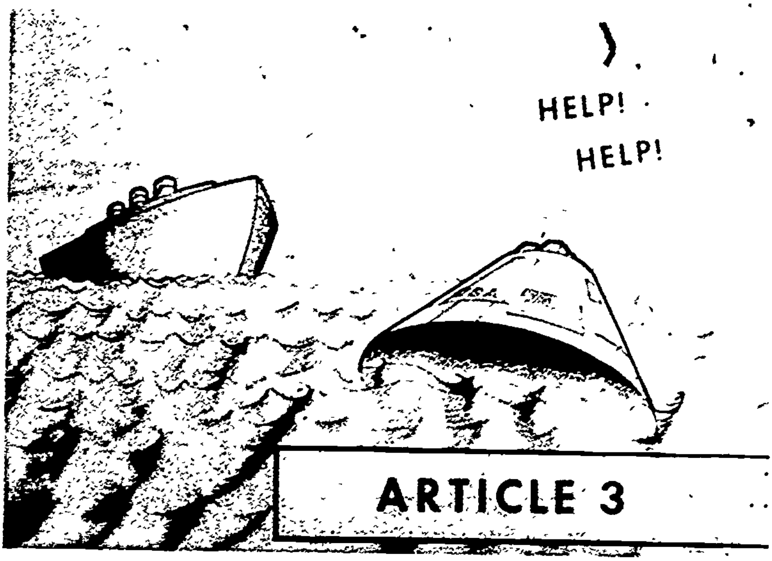


Figure 86. If astronauts make an emergency landing parties to the treaty must extend assistance in search and rescue operations (see Appendix D, Article 3, Rescue and Return Agreement, 1968).

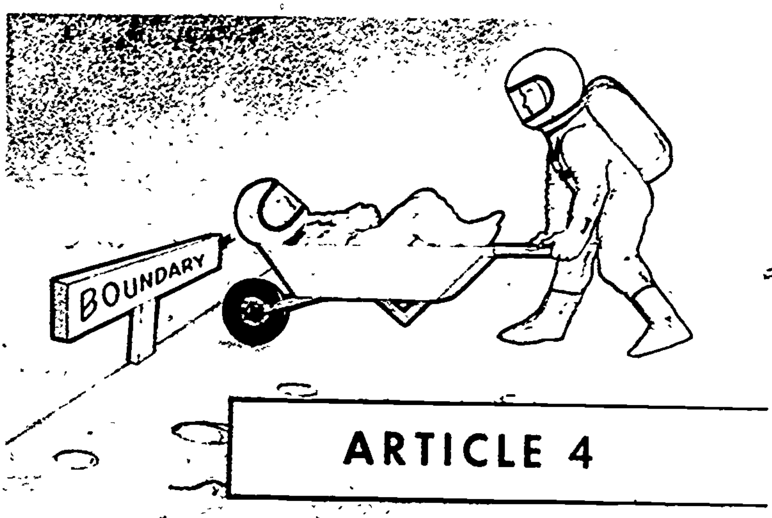


Figure 87. If astronauts were to accidently land in territory belonging to another party to the treaty, they shall be safely and promptly returned to their own representatives (see Appendix D, Article 4, Rescue and Return Agreement, 1968).

Current Questions

The term outer space (or "cosmic space" in Eastern circles) is commonly used in international agreements, UN resolutions, and the Outer Space Treaty. Therefore, it is only natural that the question has been raised as to what the term means and how it can be defined. The region of air space is subject to national sovereignty, while outer space is free for exploration and use under the conditions established summarily by the Outer Space Treaty of 1967. If this argument has not already begun to sound familiar, it is simply the same old sovereignty-jurisdiction issue with no firm definition of a line of demarcation. The sovereignty-jurisdiction issue also affects the ability of the Outer Space Treaty and the United Nations in formulating and administering effective space law. Until a definition of outer space is officially established, the Outer Space Treaty is a law with no jurisdictional enforcement.

The problem of international liability is closely connected with numerous political, economic, and social problems. For this reason, the establishment of the detailed rules and procedures connected with international liability have proven difficult to negotiate, even though the Space Treaty established the principle of international liability for damage caused by space activities (Fig. 88). Numerous problems connected with international liability remain unsolved: liability for nuclear damage, the limit on the amount of compensation, laws governing the assessment of damages, joint liability of states and international organizations, and, in particular, third party settlement procedures for claims. The Soviet Union refuses to admit the jurisdiction of the Court of International Justice. It is also reluctant to place international organizations on a par with states as far as rights and responsibilities are concerned, and, for reasons not altogether clear, it insists on the exclusion of nuclear damage from the general treaty on liability. As a result of these combined difficulties, it is still impossible to answer the rhetorical question, "Who pays you when a satellite falls on your cow?" If it happens, the lucky farmer will find that it was a US satellite, in which case he will probably get at least the current market value of the cow. An unlucky farmer will find that the satellite was foreign made and that there are no provisions for compensation.

Figure 88. The question of compensation for personal injury or loss remains unanswered.

Future Questions

Even though the Outer Space Treaty has already established the framework in which future problems can be handled, there are several questions that should be considered in advance so that we need not wait a decade for a legal solution.

At present, there is no provision for arrest and punishment of civilians who might commit murder, robbery, or similar crimes on the moon or other celestial bodies (Fig 89). Only those subject to the Uniform Code of Military Justice (UCMJ), which has universal jurisdiction, could be punished. As long as outer space is defined as free from the jurisdiction of a country, it is also free from the jurisdiction of criminal courts in those countries. Therefore, if a civilian or member of a foreign military service should kill anyone in outer space, he currently could not be punished. Clearly a Space Criminal Code should be prepared in advance of any violation.

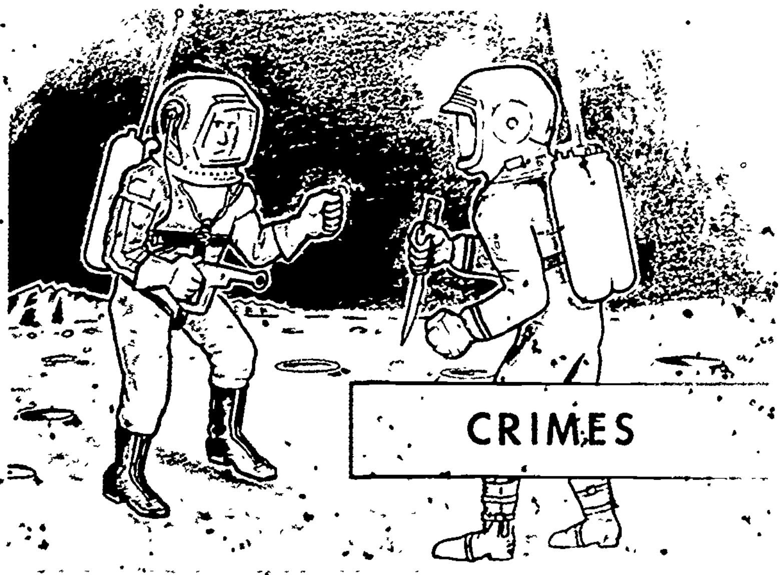


Figure 89. There is a need for a Space Criminal Code to deal with crimes in space or on celestial bodies.

Further, a space related definition of weapons is needed. Many earth "tools" could easily become lethal weapons in outer space for use against humanity or property. Although the Outer Space Treaty prohibits weapons of mass destruction, it is based on an earth concept of weapons. Without gravity or atmosphere, a wide variety of simple air pressure, magnetic, and recoil tools would be capable of building up the necessary speed and force to be highly destructive in space.

Finally, a civil code for outer space should be developed to protect the consumer from negligence and unfulfilled contracts. After all, if you purchase an advance round-trip reservation to the moon from Pan-Am, it would be to your advantage if the kind of civil laws that made them fulfill the contract on earth would be there to prevent them from leaving you on the moon. Further, should you hurt yourself while deplaning on the Moon, you would find comfort in a system of civil torts to assure compensation.

CONCLUSION

The field of space law is new and growing, even more so than space exploration. While much of the necessary work has been done, agreement is still needed on the definitions that will provide a foundation for what has already been done. The rule of custom has been challenged by the articles of the Outer Space Treaty, but, so far, custom still rules outer space (whatever it is).

WORDS, PHRASES, AND NAMES TO REMEMBER

Chicago Convention
jurisdiction
sovereignty
lines of demarcation
usque ad coelum (OOS-quay odd KOY-luhm)
Gravitation Theory
Airspace Theory
Atmosphere Theory
Aerodynamic Theory
Biological Theory
Theory of satellite orbit
The von Karman Line
Theory of effective control
Interest Theory
Security Theory
Treaty on Outer Space
Rescue and Return Agreement

QUESTIONS

1. What was the IGY and why was it important?
2. Name two international agreements (or treaties) that preceded the Outer Space Treaty.
3. What is the key issue in space law today?
4. List and define four theories of demarcation.
5. What ancient Roman legal principal did international attorneys retreat to in their search for a basis for space law?
6. List and define the two "balances" written into the Outer Space Treaty.
7. What are the arms control provisions of the Outer Space Treaty?

8. What provisions are made to verify treaty observation?

9. What does the Outer Space Treaty provide for future developments in space law?

10. What major space treaty followed the Outer Space Treaty?

11. List two unsolved questions of today in space law.

12. List two unsolved questions of tomorrow in space law.

THINGS TO DO

1. Report to the class any recent developments in the current or future questions in space law.

2. Conduct a class discussion to develop and justify your own theory of demarcation.

3. Bring to the attention of the class any offers that you notice for moon real estate, round-trip reservations to the moon, moon insurance, moon resort reservations, or any other attempt to commercialize outer space.

4. In recent years, there have been reportings of satellites crashing to earth after orbit decay. Report to the class on any such incident that you may find. Be sure to note any impact on unanswered questions of space law, such as liability for damages.

SUGGESTIONS FOR FURTHER READING

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APPENDIX A

SOVIET SPACE MISSIONS

SOVIET SPACECRAFT DESIGNATIONS

SPUTNIK- An early designation for Soviet unmanned orbiting payloads. These included scientific payloads and unmanned tests of the Vostok spacecraft.

LUNA. Unmanned payloads launched to the moon for lunar exploration. These include lunar orbiters, lunar landers, and lunar lander return missions.

MANNED SPACECRAFT:

VOSTOK: The Soviet's first manned capsule, roughly spherical, used to place the first six Cosmonauts in earth orbit.

VOSKHOD. Adaptation of the Vostok capsule to accommodate two and three Cosmonauts. Voskhod I orbited three persons and Voskhod II orbited two persons performing the first manned extravehicular activity.

SOYUZ A new manned spacecraft incorporating provisions for three Cosmonauts and a "working compartment," accessible through a hatch.

SALYUT. The first earth orbiting space station intended for prolonged occupancy and revisitation by Cosmonauts.

COSMOS Cosmos appeared as a designator in 1962 to be used for explaining many different Soviet activities in space without giving specific details each time. These have been described as including launchings from three difference sites, and probably with half a dozen or so major combinations of launch vehicles. Certain Cosmos flights were probably planetary and lunar failures which did not leave earth orbit. Others were probable precursors to manned flights.

VENUS (VENERA)- Unmanned payloads launched to explore the planet Venus.

SRET French satellite for the study of cadmium telluride and cadmium sulfate solar cells, launched on Molniya 1/20.

POLYOT Earth satellites incorporating onboard propulsion systems for changing orbits.

ELEKTRON Satellites launched in pairs (with apogees of 4000 miles, and 40,000 miles) to map radiation belts.

ZOND. Lunar and deep space probes not otherwise designated. Includes circumlunar spacecraft.

MOLNIYA A communications satellite appearing in a highly elliptical orbit over the same portion of the earth each day on each of its climbs to apogee, giving good coverage to the Soviet Union.

METEOR Earth satellites primarily for collecting and reporting worldwide meteorological (weather) data. Early weather satellites were included in the Cosmos series.

INTERCOSMOS Scientific satellites carrying experiments from other countries which make the payloads "international". The announced countries participating are from the Soviet Bloc.

OREOL Scientific satellite intended to study physical phenomena in upper atmosphere and for studying the nature of the polar lights. Launched jointly with France.

MARS. Unmanned payloads launched to explore the planet Mars.

PROGNOZ "FORECAST" - A solar irradiation and magnetosphere satellite for the study of solar plasma fluxes.

UNOFFICIAL TABULATION OF USSR SPACEFLIGHTS

UNOFFICIAL RECORD OF USSR PAYLOADS

As of 17 January 1973

		57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	TOTAL
1	Sputnik	2	1	-	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	10
2	Luna (Lunik)**	-	-	3	-	-	-	2*	-	4	5	-	1	1	2	2	1	1	-	22
3	Vostok, Voskhod	-	-	-	-	2	2	2	1	1	-	-	-	-	-	-	-	-	-	8
4	Cosmos	-	-	-	-	-	12	12	27	52	34	61	64	55	72	81	72	1	-	543
5	Venus (Venik)	-	-	-	-	-	3*	-	-	2	-	1	-	2	1	-	1	-	-	10
6	Mars	-	-	-	-	-	3*	-	-	-	-	-	-	-	-	2	-	-	-	5
7	Polyot	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	2
8	Electron	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	4
9	Zond***	-	-	-	-	-	-	-	2	1	-	-	3	1	1	-	-	-	-	8
10	Molniya	-	-	-	-	-	-	-	-	2	2	3	3	2	5	3	6	-	-	26
11	Proton	-	-	-	-	-	-	-	-	2	1	-	1	-	-	-	-	-	-	4
12	Soyuz (Union)	-	-	-	-	-	-	-	-	-	-	1	2	5	1	2	-	-	-	11
13	Meteor	-	-	-	-	-	-	-	-	-	-	-	-	2	4	4	3	-	-	13
14	Intercosmos	-	-	-	-	-	-	-	-	-	-	-	-	2	2	1	3	-	-	8
15	No Designation	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
16	Salyut-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
17	Oreol-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
18	SRET (French payload)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
19	PROGNOZ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
	Total to Date	2	1	3	3	6	20	17	35	64	44	66	74	70	88	97	89	2	-	681

See Unofficial Record of USSR Missions on next few pages for information on selected flights

Source of information Foreign Broadcasting Information Service

* Includes launches identified by U S but not announced by USSR

** Cannot carry man

*** Capable of carrying man

TERMINOLOGY USED IN

UNOFFICIAL RECORD OF USSR SPACECRAFT

RECOVERED 1/ - Assumed spacecraft commanded to reentry in planned fashion

DECAYED 1/ - Assumed spacecraft orbit degenerated into reentry

DOWN 1/ - Unclear whether spacecraft was recovered or decayed

ASTERISK* - Mission appeared to be unsuccessful by gross evaluation of orbital characteristics

POUNDS# - Weights released by Soviet Union as that of spacecraft

1 Provided in the Status column where no objectives of spacecraft were announced by Soviet Union Can be used to group missions of similar duration i e , 8-day missions

UNOFFICIAL RECORD OF USSR MISSIONS

NAME	LAUNCH	INCLINATION	STATUS
1957			
Sputnik 1	4 Oct	65 1	Decayed 4 Jan 58
Sputnik 2	3 Nov	65 3	Decayed 14 Apr 58
1958			
Sputnik 3	15 May	65 2	Decayed 6 Apr 60
1959			
Lunik 1	2 Jan	----	Lunar probe, 3245#
Lunik 2	12 Sep	----	Lunar impact, 15 Sep 59
Lunik 3	4 Oct	----	Decayed 29 Apr 60
1960			
Sputnik 4	15 May	65 0	Decayed 15 Oct 65
Sputnik 5	19 Aug	64 9	Successfully recov 20 Aug 60 w/dogs
* None	10 Oct	----	Mars probe failed
* None	14 Oct	----	Mars probe failed
* Sputnik 6	1 Dec	65 0	Decayed 2 Dec 60
1961			
* Sputnik 7	4 Feb	65 0	Decayed 26 Feb 61
Sputnik 8	12 Feb	65 0	Recov 25 Feb 61
* Venus Probe	12 Feb	----	Venus probe, 1419#
Sputnik 9	9 Mar	64 9	Recov 9 Mar 61
Sputnik 10	25 Mar	64 9	Recov 25 Mar 61.
Vostok 1	12 Apr	65 0 Manned	Gagarin, Reentered 12 April 61
Vostok 2	6 Aug	64.9 Manned	Titov; Reentered 7 Aug 61

*Unsuccessful

NAME	LAUNCH	INCLINATION	STATUS
1962			
Cosmos 1	16 Mar	49 0	Decayed 25 May 62
Cosmos 2	6 Apr	49 0	Decayed 19 Aug 6?
Cosmos 3	24 Apr	49 0	Decayed 17 Oct 64
Cosmos 4	26 Apr	65 0	Recovered 29 Apr 62
Cosmos 5	28 May	49 1	Decayed 2 May 63
Cosmos 6	30 Jun	48 9	Decayed 8 Aug 62
Cosmos 7	28 Jul	65 0	Recovered 1 Aug 62
Vostok 3	11 Aug	65 0	Manned: Nikolayev, Recov 15 Aug 62
Vostok 4	12 Aug	65 0	Manned Popovich, Recov 15 Aug 62
Cosmos 8	18 Aug	49 0	Decayed 17 Aug 63
* None	25 Aug	98 6	Venus probe; Decayed 28 Aug 62
* None	1 Sep		Venus probe, Decayed 6 Sep 62
* None	12 Sep		Venus probe; Decayed 14 Sep 62
Cosmos 9	27 Sep	65 0	Recovered 1 Oct 62
Cosmos 10	17 Oct	65 0	Recovered 21 Oct 62
Cosmos 11	20 Oct	49 0	Decayed 18 May 64
* None	24 Oct	----	Mars probe, Decayed 29 Oct 62
* Mars 1	1 Nov	----	Mars probe, 1965#
* None	4 Nov	----	Mars probe, Decayed 5 Nov 62
Cosmos 12	22 Dec	65 0	Recovered 30 Dec 62
1963			
* None	4 Jan	----	Lunar probe, Decayed 5 Jan 62
Cosmos 13	21 Mar	65 0	Recovered 29 Mar 63
Lunik 4	2 Apr	----	Lunar probe, 3135#
Cosmos 14	13 Apr	48 6	Decayed 29 Aug 63
Cosmos 15	22 Apr	65 0	Recovered 27 Apr 63
Cosmos 16	28 Apr	65 0	Recovered 8 May 63

NAME	LAUNCH	INCLINATION	STATUS
1963 (cont'd)			
Cosmos 17	22 May	49.0	Decayed 2 Jun 65
Cosmos 18	24 May	65 0	Recovered 2 Jun 63
Vostok 5	14 Jun	65 0	Manned: Bykovsky, Recov 19 Jun 63
Vostok 6	16 Jun	65 0	Manned: Tereshkova, Recov 19 Jun 63
Cosmos 19	6 Aug	49 0	Decayed 30 Mar 64
Cosmos 20	18 Oct	65.0	Recovered 30 Oct 63
Polyot 1	1 Nov	59 0	Maneuver capability
Cosmos 21	11 Nov	64.9	Recovered 14 Nov 63
Cosmos 22	16 Nov	64 9	Recovered 22 Nov 63
Cosmos 23	13 Dec	49.0	Decayed 27 Mar 64
Cosmos 24	19 Dec	65.0	Recovered 28 Dec 63
1964			
Elektron 1	30 Jan	61 0 } dual	Radiation belt
Elektron 2	30 Jan	61.0 } launch	Radiation belt

NAME	LAUNCH	INCLINATION	STATUS
1964 (cont'd)			
Elektron 3	11 Jul	61.0 } dual	Radiation belt
Elektron 4	11 Jul	61 0 } launch	Radiation belt
Cosmos 35	15 Jul	51 3	Recovered 23 Jul 64
Cosmos 36	30 Jul	49.0	Decayed 28 Feb 65
Cosmos 37	14 Aug	65 0	Recovered 23 Aug 64
Cosmos 38	19 Aug	56 2 } triple	Decayed 8 Nov 64
Cosmos 39	19 Aug	56 2 } launch	Decayed 17 Nov 64
Cosmos 40	19 Aug	56.2 }	Decayed 18 Nov 64
Cosmos 41	22 Aug	64 0	In orbit
Cosmos 42	22 Aug	49 0 } dual	Decayed 19 Dec 65
Cosmos 43	22 Aug	49 0 } launch	Decayed 27 Dec 65
Cosmos 44	29 Aug	65.0	In orbit
Cosmos 45	13 Sep	64 9	Recovered 18 Sep 64
Cosmos 46	24 Sep	50 3	Recovered 2 Oct 64
Cosmos 47	6 Oct	64.8	Recovered 7 Oct 64

Cosmos 25	27 Feb	49.0	Decayed 21 Nov 64
Cosmos 26	18 Mar	49.0	Decayed 28 Sep 64
Cosmos 27	27 Mar	64 8	Recovered 28 Mar 64
Zond 1	2 Apr	----	Interplanetary probe
Cosmos 28	4 Apr	65.0	Recovered 12 Apr 64
Polyot 2	12 Apr	58.1	Decayed 8 Jun 66
Cosmos 29	25 Apr	65 1	Recovered 2 May 64
Cosmos 30	18 May	64 9	Recovered 26 May 64
Cosmos 31	6 Jun	49	Decayed 20 Oct 64
Cosmos 32	10 Jun	51.3	Recovered 18 Jun 64
Cosmos 33	23 Jun	65.0	Recovered 1 Jul 64
Cosmos 34	1 Jul	65 0	Recovered 9 Jul 64

Voskhod 1	12 Oct	65 0	Manned: Komarov, Feoktistov, and Yegorov
Cosmos 48	~14 Oct	65 0	Recovered 20 Oct 64
Cosmos 49	24 Oct	49 0	Decayed 21 Aug 65
Cosmos 50	28 Oct	51 3	Decayed 5 Nov 64
Zond 2	30 Nov	----	Mars probe
Cosmos 51	9 Dec	48.8	Decayed 14 Nov 65
1965			
Cosmos 52	11 Jan	65.0	Recovered 19 Jan 65
Cosmos 53	30 Jan	48.8	Decayed 12 Aug 66

1965 (cont'd)				
Cosmos 54	21 Feb	56.0	triple launch	Decayed 15 Sep 68
Cosmos 55	21 Feb	56 0		Decayed 2 Feb 68
Cosmos 56	21 Feb	56 0		Decayed 2 Nov 67
Cosmos 57	22 Feb	64 7		Decayed 22 Feb 65
Cosmos 58	26 Feb	65 0		In orbit
Cosmos 59	7 Mar	65.0		Recovered 15 Mar 65
Cosmos 60	12 Mar	64 7		Decayed 17 Mar 65
Cosmos 61	15 Mar	56 0	triple launch	Decayed 15 Jan 68
Cosmos 62	15 Mar	56.0		Decayed 24 Sep 68
Cosmos 63	15 Mar	56 0		Decayed 4 Nov 67
Voskhod II	18 Mar	65 0		Manned: Belyayev and Leonov EVA. Recovered 19 Mar 65
Cosmos 64	25 Mar	65 0		Recovered 2 Apr 65
Cosmos 65	17 Apr	65 0		Recovered 25 Apr 65
Molniya 1-1	23 Apr	65 0		Communications
Cosmos 66	7 May	65 0		Recovered 15 May 65
Lunik 5	9 May	----		Lunar impact 12 May 65
Cosmos 67	25 May	51 8		Recovered 2 Jun 65
Lunik 6	8 Jun	----		Lunar probe
Cosmos 68	15 Jun	65 0		Recovered 23 Jun 65
Cosmos 69	25 Jun	65 0		Recovered 3 Jul 65
Cosmos 70	2 Jul	48.8		Decayed 18 Dec 66
Cosmos 71	16 Jul	56 1	quintuple launch	Decayed 11 Aug 70
Cosmos 72	16 Jul	56 1		In orbit
Cosmos 73	16 Jul	56 1		In orbit
Cosmos 74	16 Jul	56 1		In orbit
Cosmos 75	16 Jul	56 1		In orbit

1965 (cont'd)				
Proton 1	16 Jul	63 5		Decayed 11 Oct 65, 27,000[f]
Zond 3	18 Jul	----		Lunar photography
Cosmos 76	23 Jul	48.8		Decayed 16 Mar 66
Cosmos 77	3 Aug	51 8		Recovered 11 Aug 65
Cosmos 78	14 Aug	68 9		Recovered 22 Aug 65
Cosmos 79	25 Aug	64 9		Recovered 2 Sep 65
Cosmos 80	3 Sep	56 0	quintuple launch	
Cosmos 81	3 Sep	56 0		Second such launch
Cosmos 82	3 Sep	56 0		Carried radioactive isotope
Cosmos 83	3 Sep	56 0		power source
Cosmos 84	3 Sep	56 0		
Cosmos 85	9 Sep	65.0		Recovered 17 Sep 65
Cosmos 86	18 Sep	56 0	quintuple launch	
Cosmos 87	18 Sep	56.0		Third such launch.
Cosmos 88	18 Sep	56.0		Carried radioactive isotope
Cosmos 89	18 Sep	56 0		power source
Cosmos 90	18 Sep	56 0		
Cosmos 91	23 Sep	65 0		Recovered 1 Oct 65
Lunik 7	4 Oct	----		Lunar impact 7 Oct 65
Molniya 1-2	14 Oct	65 0		Decayed 17 Mar 67
Cosmos 92	16 Oct	65 0		IR and UV sensors/Down 24 Oct 65
Cosmos 93	19 Oct	48 5		Decayed 3 Jan 66
Cosmos 94	28 Oct	65 0		Recovered 5 Nov 65
Proton 2	2 Nov	63 5		Decayed 6 Feb 66
Cosmos 95	4 Nov	48 4		Decayed 18 Jan 66
Venus 2	12 Nov	----		Venus probe, 2100[f]
Venus 3	16 Nov	----		Recovered 1 Mar 66

UNOFFICIAL RECORD OF USSR MISSIONS

NAME	LAUNCH	INCLINATION	STATUS
1965 (cont'd)			
*Cosmos 96	23 Nov	51.9	Decayed 9 Dec 65
Cosmos 97	26 Nov	49.0	Decayed 2 Apr 67
Cosmos 98	27 Nov	64.0	Recovered 5 Dec 65
Lunik 8	3 Dec	----	Lunar impact 6 Dec 65
Cosmos 99	10 Dec	65.0	Recovered 18 Dec 65
Cosmos 100	17 Dec	64.9	In orbit
Cosmos 101	21 Dec	49.0	Decayed 12 Jul 66
Cosmos 102	27 Dec	65.0	Decayed 13 Jan 66
Cosmos 103	28 Dec	56.0	In orbit
1966			
Cosmos 104	7 Jan	65.0	Recovered 15 Jan 66
Cosmos 105	22 Jan	65.0	Recovered 30 Jan 66
Cosmos 106	25 Jan	48.4	Decayed 14 Nov 66
Lunik 9	31 Jan	----	Lunar soft-landing, 3520#
Cosmos 107	10 Feb	65.0	Recovered 18 Feb 66
Cosmos 108	11 Feb	48.9	Decayed 21 Nov 66
Cosmos 109	19 Feb	65	Recovered 27 Feb 66
Cosmos 110	22 Feb	51.9	Recovered 16 Mar 66
Cosmos 111	1 Mar	51.9	Decayed 3 Mar 66
Cosmos 112	17 Mar	72.0	Recovered 25 Mar 66
Cosmos 113	21 Mar	65.0	Recovered 29 Mar 66
Lunik 10	31 Mar	----	Lunar orbiter
Cosmos 114	6 Apr	73.0	Recovered 14 Apr 66
Cosmos 115	20 Apr	65.0	Recovered 28 Apr 66
Molniya 1-3	25 Apr	64.5	Communications
Cosmos 116	25 Apr	48.5	Decayed 3 Dec 66
1967			
Cosmos 138	19 Jan	65.0	Recovered 27 Jan 67
Cosmos 139	25 Jan	50.0	Recovered 25 Jan 67
Cosmos 140	7 Feb	51.7	Recovered 9 Feb 67
Cosmos 141	8 Feb	72.9	Recovered 16 Feb 67
Cosmos 142	14 Feb	48.4	Decayed 6 Jul 67
Cosmos 143	27 Feb	65.0	Recovered 7 Mar 67
Cosmos 144	28 Feb	81.2	Meteorology
Cosmos 145	3 Mar	48.4	Decayed 8 Mar 68
Cosmos 146	10 Mar	51.5	Recovered 18 Mar 67
Cosmos 147	15 Mar	65.0	Recovered 21 Mar 67
Cosmos 148	16 Mar	71.0	Decayed 7 May 67
Cosmos 149	21 Mar	48.4	Decayed 7 Apr 67
Cosmos 150	22 Mar	65.7	Recovered 30 Mar 67
Cosmos 151	24 Mar	56.0	In orbit
Cosmos 152	25 Mar	71.0	Decayed 5 Aug 67

* Unsuccessful

NAME	LAUNCH	INCLINATION	STATUS
1966 (cont'd)			
Cosmos 117	6 May	65.0	Recovered 14 May 66
Cosmos 118	11 May	65.0	In orbit
Cosmos 119	24 May	48.5	Decayed 30 Nov 66
Cosmos 120	8 Jun	51.8	Recovered 16 Jun 66
Cosmos 121	17 Jun	72.9	Recovered 25 Jun 66
Cosmos 122	25 Jun	65.0	Meteorology
Proton 3	6 Jul	63.5	Decayed 16 Sep 66
Cosmos 123	8 Jul	48.8	Decayed 10 Dec 66
Cosmos 124	14 Jul	51.8	Recovered 22 Jul 66
Cosmos 125	20 Jul	65.0	Decayed 2 Aug 66
Cosmos 126	28 Jul	51.8	Recovered 6 Aug 66
Cosmos 127	8 Aug	51.9	Recovered 16 Aug 66
Luna 11	24 Aug	----	Lunar orbiter, 3608#
Cosmos 128	27 Aug	65.0	Recovered 4 Sep 66
None	17 Sep	----	150 pieces or fragments
Cosmos 129	14 Oct	65.0	Recover 21 Oct 66
Cosmos 130	20 Oct	65.0	Recovered 28 Oct 66
Molniya 1-4	20 Oct	64.9	Decayed 11 Sep 68
Luna 12	22 Oct	----	Lunar photography
None	2 Nov	----	Numerous fragments
Cosmos 131	12 Nov	72.9	Recovered 20 Nov 66
Cosmos 132	19 Nov	65.0	Recovered 27 Nov 66
Cosmos 133	28 Nov	52.0	Recovered 30 Nov 66
Cosmos 134	3 Dec	65.0	Recovered 11 Dec 66
Cosmos 135	12 Dec	48.5	Decayed 12 Apr 67
Cosmos 136	19 Dec	64.6	Recovered 27 Dec 66
Luna 13	21 Dec	----	Landed on Moon 24 Dec 66
Cosmos 137	21 Dec	48.8	Decayed 23 Nov 67
1967 (cont'd)			
Cosmos 162	1 Jun	51.8	Recovered 9 Jun 67
Cosmos 163	5 Jun	48.4	Decayed 11 Oct 67
Cosmos 164	8 Jun	65.7	Recovered 14 Jun 67
Venus 4	12 Jun	----	Decayed 18 Oct 67
Cosmos 165	12 Jun	81.9	Decayed 15 Jan 68
Cosmos 166	16 Jun	48.4	Decayed 25 Oct 67
Cosmos 167	17 Jun	51.8	Decayed 25 Jun 67
Cosmos 168	4 Jul	51.8	Recovered 12 Jul 67
Cosmos 169	17 Jul	50.0	Recovered 17 Jul 67
Cosmos 170	31 Jul	50.0	Recovered 31 Jul 67
Cosmos 171	8 Aug	50.0	Recovered 8 Aug 67
Cosmos 172	9 Aug	51.8	Recovered 17 Aug 67
Cosmos 173	24 Aug	71.0	Decayed 17 Dec 67
Cosmos 174	31 Aug	64.5	Decayed 30 Dec 68. Molniya parameter

Cosmos 153	4 Apr	64 6	Recovered 12 Apr 67
Cosmos 154	8 Apr	51 6	Decayed 10 Apr 67
Cosmos 155	12 Apr	51 8	Recovered 20 Apr 67
*Soyuz 1	22 Apr	51 7	Manned Reentry killed Col. Komarov 24 Apr 67
Cosmos 156	27 Apr	81 2	Meteorology
Cosmos 157	12 May	51 3	Recovered 20 May 67
Cosmos 158	15 May	74 4	In orbit
Cosmos 159	17 May	51 9	In orbit Molniya parameters
Cosmos 160	17 May	49 6	Decayed 18 May 67
Cosmos 161	22 May	65 7	Recovered 30 May 67
Molniya 1-5	25 May	64 0	Decayed 26 Nov 71

*Unsuccessful

Cosmos 175	11 Sep	72 9	Recovered 19 Sep 67
Cosmos 176	12 Sep	81.9	Decayed 3 Mar 68
Cosmos 177	16 Sep	51 8	Recovered 24 Sep 67
Cosmos 178	19 Sep	50 0	Recovered 19 Sep 67
Cosmos 179	22 Sep	50.0	Recovered 22 Sep 67
Cosmos 180	26 Sep	72 9	Recovered 4 Oct 67
Molniya 1-6	3 Oct	65.0	Decayed 4 Mar 69
Cosmos 181	11 Oct	65 6	Recovered 18 Oct 67
Cosmos 182	16 Oct	65 0	Recovered 24 Oct 67
Cosmos 183	18 Oct	50 0	Recovered 18 Oct 67
Molniya 1-7	22 Oct	64 7	Decayed 31 Dec 69
Cosmos 184	25 Oct	81 2	Meterology
Cosmos 185	27 Oct	64.1	Decayed 14 Jan 69

1967 (cont'd)			
Cosmos 186	27 Oct	51 7	Recovered 31 Oct 67/docked with #186
Cosmos 187	27 Oct	50.0	Recovered 28 Oct 67
Cosmos 188	30 Oct	51 7	Recovered 2 Nov 67/docked with #186
Cosmos 189	30 Oct	74 0	In orbit
Cosmos 190	3 Nov	65 7	Recovered 11 Nov 67
Cosmos 191	21 Nov	71.0	Decayed 2 Mar 68
Cosmos 192	23 Nov	74.0	In orbit
Cosmos 193	25 Nov	65 7	Recovered 3 Dec 67
Cosmos 194	3 Dec	65 7	Recovered 11 Dec 67
Cosmos 195	16 Dec	65 7	Recovered 23 Dec 67
Cosmos 196	19 Dec	49 0	Decayed 7 Jul 68
Cosmos 197	26 Dec	48.5	Decayed 30 Jan 68
Cosmos 198	27 Dec	65 1	In orbit. In-plane maneuver
1968			
Cosmos 199	16 Jan	65.7	Decayed 1 Feb 68
Cosmos 200	19 Jan	74.0	In orbit
Cosmos 201	6 Feb	65 0	Recovered 14 Feb 68
Cosmos 202	20 Feb	48.4	Decayed 24 Mar 68
Cosmos 203	20 Feb	74 1	In orbit
Zond 4	2 Mar	----	Circumlunar (?)
Cosmos 204	5 Mar	71 0	Decayed 2 Mar 69
Cosmos 205	5 Mar	65 7	Recovered 13 Mar 68
Cosmos 206	14 Mar	81.0	Meteorology
Cosmos 207	16 Mar	65.6	Recovered 24 Mar 68
Cosmos 208	21 Mar	65 0	Recovered 2 Apr 68
Cosmos 209	22 Mar	65 1	In orbit

1968 (cont'd)			
Cosmos 210	3 Apr	81.2	Recovered 11 Apr 68
Lunar 14	7 Apr		Lunar Orbit
Cosmos 211	9 Apr	81 9	Decayed 10 Nov 68
Cosmos 212	14 Apr	51 7	Recovered 19 Apr 68/docked with #213
Cosmos 213	15 Apr	51 4	Recovered 20 Apr 68 /target for #212
Cosmos 214	18 Apr	81 4	Recovered 26 Apr 68
Cosmos 215	19 Apr	48 5	Decayed 30 Jun 68
Cosmos 216	20 Apr	51 8	Recovered 28 Apr 68
Molniya 1-8	21 Apr	65	Communications
Cosmos 217	24 Apr	62 2	Decayed 26 Apr 68
Cosmos 218	25 Apr	50.0	One orbit Recovered 25 Apr 68
Cosmos 219	26 Apr	48 4	Decayed 2 Mar 69
Cosmos 220	7 May	74	In orbit
Cosmos 221	24 May	48 4	Decayed 31 Aug 69
Cosmos 222	31 May	71	Decayed 11 Oct 68
Cosmos 223	1 Jun	72 9	Recovered 9 Jun 68
Cosmos 224	4 Jun	51 8	Recovered 12 Jun 68
Cosmos 225	11 Jun	48 4	Decayed 2 Nov 68
Cosmos 226	12 Jun	81 2	Meteorology
Cosmos 227	18 Jun	51 8	Recovered 26 Jun 68
Cosmos 228	21 Jun	51 6	Recovered 3 Jul 68
Cosmos 229	26 Jun	72.8	Recovered 4 Jul 68
Cosmos 230	5 Jul	48 5	Decayed 2 Nov 68
Molniya 1-9	5 Jul	65	Decayed 15 May 71
Cosmos 231	10 Jul	65	Recovered 18 Jul 68
Cosmos 232	16 Jul	65	Recovered 24 Jul 68
Cosmos 233	18 Jul	82	Decayed 7 Feb 69

UNOFFICIAL RECORD OF USSR MISSIONS

NAME	LAUNCH	INCLINATION	STATUS
1968 (cont'd)			
Cosmos 234	30 Jul	51.8	Recovered 5 Aug 68
Cosmos 235	9 Aug	51.8	Recovered 17 Aug 68
Cosmos 236	27 Aug	56.0	In orbit
Cosmos 237	27 Aug	65.4	Recovered 4 Sep 68
Cosmos 238	28 Aug	51.7	Recovered 1 Sep 68
Cosmos 239	5 Sep	51.8	Recovered 13 Sep 68
Cosmos 240	14 Sep	51.8	Recovered 21 Sep 68
Zond 5	14 Sep	Circumlunar	Recovered 21 Sep 68 in Indian Ocean
Cosmos 241	16 Sep	65.4	Recovered 24 Sep 68
Cosmos 242	20 Sep	71.0	Decayed 13 Nov 68
Cosmos 243	23 Sep	71.3	Recovered 4 Oct 68
Cosmos 244	2 Oct	50.0	One orbit: Recovered 2 Oct 68
Cosmos 245	3 Oct	71.0	Decayed 15 Jan 69
Molniya I-10	5 Oct	65.0	In orbit
Cosmos 246	7 Oct	65.4	Recovered 12 Oct 68
Cosmos 247	11 Oct	65.4	Recovered 19 Oct 68
Cosmos 248	19 Oct	62.3	In orbit
Cosmos 249	20 Oct	62.4	In orbit
Soyuz 2	25 Oct	51.7	Target for Soyuz 3/Recovered 28 Oct 68
Soyuz 3	26 Oct	52.0	Manned: Beregovoy Rendezvoused with Soyuz 2 Recovered 30 Oct 68
Cosmos 250	31 Oct	74.0	In orbit
Cosmos 251	31 Oct	65.0	Recovered 18 Nov 68
Cosmos 252	1 Nov	61.9	In orbit
Zond 6	10 Nov	Circumlunar	Recovered 17 Nov 68
1968 (cont'd)			
Cosmos 253	13 Nov	65.4	Recovered 18 Nov 68
Proton 4	16 Nov	51.5	Decayed 24 Jul 69
Cosmos 254	21 Nov	65.4	Recovered 29 Nov 68
Cosmos 255	29 Nov	65.4	Recovered 7 Dec 68
Cosmos 256	30 Nov	74.1	In orbit
Cosmos 257	3 Dec	71.0	Decayed 5 Mar 69
Cosmos 258	10 Dec	65.0	Recovered 18 Dec 68
Cosmos 259	14 Dec	48.5	Decayed 5 May 69
Cosmos 260	16 Dec	65.0	In orbit: Molniya parameters
Cosmos 261	20 Dec	71.0	Decayed 12 Feb 69
Cosmos 262	26 Dec	48.5	Decayed 18 Jul 69
1969			
Venus 5	5 Jan		Landed 16 May 69
Venus 6	10 Jan		Landed 17 May 69
Cosmos 263	12 Jan	65.4	Recovered 20 Jan 69
Soyuz 4	14 Jan	51.7	Recovered 17 Jan 69 Manned: Shatalov
Soyuz 5	15 Jan	51.7	Recovered 18 Jan 69 Manned crew transfer to Soyuz 4: Volynov, Yeliseyev, and Khrunov
Cosmos 264	23 Jan	70.0	Recovered 5 Feb 69
Cosmos 265	7 Feb	71.0	Decayed 1 May 69
Cosmos 266	25 Feb	72.9	Recovered 5 Mar 69
Cosmos 267	26 Feb	89.8	Recovered 6 Mar 69
1969 (Cont'd)			
Cosmos 268	5 Mar	48.4	Decayed 9 May 70
Cosmos 269	5 Mar	74.0	In orbit
Cosmos 270	6 Mar	65.4	Recovered 14 Mar 69
Cosmos 271	15 Mar	89.7	Recovered 23 Mar 69
Cosmos 272	17 Mar	74.0	In orbit
Cosmos 273	22 Mar	65.4	Recovered 30 Mar 69
Cosmos 274	24 Mar	65 0	Recovered 1 Apr 69
Meteor-1	26 Mar	81 2	Meteorological Satellite
Cosmos 275	28 Mar	70 9	Decayed 7 Feb 70
Cosmos 276	4 Apr	81 3	Recovered 11 Apr 69
Cosmos 277	4 Apr	70 9	Decayed 6 Jul 69
Cosmos 278	9 Apr	65 0	Recovered 17 Apr 69
Molniya 1/11	11 Apr	65 0	Communications Satellite
1969 (Cont'd)			
Cosmos 291	6 Aug	62.3	Decayed 8 Sep 69
Zond 7	8 Aug	Circumlunar	Recovered 14 Aug 69
Cosmos 292	14 Aug	74 0	In orbit
Cosmos 293	16 Aug	51 8	Decayed 28 Aug 69
Cosmos 294	19 Aug	65 4	Recovered 27 Aug 69
Cosmos 295	22 Aug	71.0	Decayed 1 Dec 69
Cosmos 296	29 Aug	65 0	Recovered 6 Sep 69
Cosmos 297	2 Sep	72.9	Recovered 10 Sep 69
Cosmos 298	15 Sep	50 0	Recovered 15 Sep 69
Cosmos 299	18 Sep	65 0	Recovered 22 Sep 69
Cosmos 300	23 Sep	51.0	Decayed 27 Sep 69
Cosmos 301	24 Sep	65 4	Recovered 2 Oct 69
Meteor-2	6 Oct	81 2	Meteorological Satellite

Cosmos 279	15 Apr	51.8	Recovered 23 Apr 69
Cosmos 280	23 Apr	51 6	Recovered 6 May 69
Cosmos 281	13 May	65 4	Recovered 21 May 69
Cosmos 282	20 May	89.8	Recovered 28 May 69
Cosmos 283	27 May	82.0	Decayed 10 Dec 69
Cosmos 284	29 May	51 8	Recovered 6 Jun 69
Cosmos 285	3 Jun	71.0	Decayed 7 Oct 69
Cosmos 286	15 Jun	65.4	Recovered 23 Jun 69
Cosmos 287	24 Jun	51 8	Recovered 2 Jul 69
Cosmos 288	27 Jun	51 8	Recovered 5 Jul 69
Cosmos 289	10 Jul	65 4	Recovered 15 Jul 69
Luna 15	13 Jul		Landed on moon 21 Jul 69
Cosmos 290	22 Jul	65.4	Recovered 30 Jul 69
Molniya 1/12	22 Jul	64 9	Decayed 18 Jun 71

Soyuz 6	11 Oct	51 7	Recovered 16 Oct 69; manned flight--Gergiy Shonin, Valriy Kubasov
Soyuz 7	12 Oct	51.7	Recovered 17 Oct 69; manned flight--Anatoley Filipchenko, Viktor Gorbakov, and Vladislav Volkov
Soyuz 8	13 Oct	51.7	Recovered 18 Oct 69; manned flight--Vladimir Shatalov, Aleksey Yeliseyev
Intercosmos-1	14 Oct	48 4	Decayed 2 Jan 70
Cosmos 302	17 Oct	65.4	Recovered 25 Oct 69
Cosmos 303	18 Oct	71.0	Decayed 23 Jan 70
Cosmos 304	21 Oct	74.0	In orbit

1969 (Con't)

Cosmos 305	22 Oct	51 5	Decayed 24 Oct 69
Cosmos 306	24 Oct	65 0	Recovered 5 Nov 69
Cosmos 307	24 Oct	48.4	Decayed 30 Dec 70
Cosmos 308	4 Nov	71 0	Decayed 5 Jan 70
Cosmos 309	12 Nov	65 4	Decayed 20 Nov 69
Cosmos 310	15 Nov	65 0	Recovered 23 Nov 69
Cosmos 311	24 Nov	71 0	Decayed 10 Mar 70
Cosmos 312	25 Nov	74.0	In orbit
Cosmos 313	3 Dec	65 4	Recovered 15 Dec 69
Cosmos 314	11 Dec	71 0	Decayed 22 Mar 70
Cosmos 315	20 Dec	74 0	In orbit
Cosmos 316	23 Dec	49 5	Decayed 28 Aug 70
Cosmos 317	23 Dec	65.4	Recovered 5 Jan 70
Intercosmos-2	25 Dec	48 4	Decayed 7 Jun 70

1970

Cosmos 318	9 Jan	65.0	Recovered 21 Jan 70
Cosmos 319	15 Jan	82.0	Decayed 1 Jul 70
Cosmos 320	16 Jan	48.5	Decayed 10 Feb 70
Cosmos 321	20 Jan	71.0	Decayed 23 Mar 70
Cosmos 322	21 Jan	65.4	Recovered 29 Jan 70
Cosmos 323	10 Feb	65.4	Recovered 18 Feb 70
Molniya 1-13	19 Feb	65.3	In orbit
Cosmos 324	27 Feb	71.0	Decayed 23 May 70
Cosmos 325	4 Mar	65 4	Recovered 12 Mar 70
Cosmos 326	13 Mar	81.0	Recovered 21 Mar 70
Meteor 3	17 Mar	81.2	Meteorological Satellite
Cosmos 327	18 Mar	71.0	Decayed 19 Jan 71

1970 (Con't)

Cosmos 328	27 Mar	72 9	Recovered 9 Apr 70
Cosmos 329	3 Apr	31.3	Recovered 15 Apr 70
Cosmos 330	7 Apr	74.1	In orbit
Cosmos 331	8 Apr	65.0	Recovered 16 Apr 70
Cosmos 332	11 Apr	74.5	In orbit
Cosmos 333	15 Apr	81.4	Recovered 28 Apr 70
Cosmos 334	23 Apr	71.0	Decayed 9 Aug 70
Cosmos 335	24 Apr	48.7	Decayed 22 Jun 70
Cosmos 336		74.0	In orbit
Cosmos 337		74.0	In orbit
Cosmos 338		74.0	In orbit
Cosmos 339	25 Apr	74.0	In orbit
Cosmos 340	Multiple	74.0	In orbit
Cosmos 341	Launch	74.0	In orbit
Cosmos 342		74.0	In orbit
Cosmos 343		74.0	In orbit
Meteor 4	28 Apr	81.2	Meteorological Satellite
Cosmos 344	12 May	72.9	Recovered 20 May 70
Cosmos 345	20 May	51.8	Recovered 28 May 70
Soyuz 9	1 Jun	51.7	Manned: Andriyan Nikolayev, V. Sevastianov-Recv 6/19/70
Cosmos 346	10 Jun	51.8	Recovered 17 Jun 70
Cosmos 347	12 Jun	48.4	Decayed 7 Nov 71
Cosmos 348	13 Jun	71.0	Decayed 25 Jul 70
Cosmos 349	17 Jun	65.4	Recovered 25 Jun 70
Meteor 5	23 Jun	81.2	Meteorological Satellite
Cosmos 350	26 Jun	51.8	Recovered 8 Jul 70
Molniya 1/14	26 Jun	65.0	Communications Satellite

UNOFFICAL RECORD OF USSR MISSIONS

NAME	LAUNCH	INCLINATION	STATUS
1970 (Con't)			
Cosmos 351	27 Jun	71.0	Decayed 13 Oct 70
Cosmos 352	7 July	51.8	Recovered 15 Jul 70
Cosmos 353	9 July	65.4	Recovered 21 Jul 70
Cosmos 354	28 July	50.0	Recovered 1st. orbit 28 Jul 70
Cosmos 355	7 Aug	66.4	Recovered 15 Aug 70
Intercosmos 3	7 Aug	49.0	Decayed 6 Dec 70
Cosmos 356	10 Aug	82.0	Decayed 2 Oct 70
Venus 7	17 Aug	Payload 2596 lbs.	Encountered 15 Dec 70
Cosmos 357	19 Aug	71.0	Decayed 24 Nov 70
Cosmos 358	20 Aug	74.0	In orbit.
Cosmos 359	22 Aug	51.5	Decayed 6 Nov 70
Cosmos 360	29 Aug	65.0	Recovered 8 Sep 70
Cosmos 361	8 Sep	72.0	Recovered 21 Sep 70
Luna 16	12 Sep		Soft landed on moon 20 Sep 70 in the Sea of Fertility. 24 Sep 70 returned with lunar rock sample.
Cosmos 362	16 Sep	71.0	Decayed 13 Oct 71
Cosmos 363	17 Sep	65.0	Recovered 29 Sep 70
Cosmos 364	22 Sep	65.4	Recovered 2 Oct 70
Cosmos 365	25 Sep	49.5	Recovered first orbit 25 Sep 70
Molniya 1/15	29 Sep	65.5	Communications Satellite
Cosmos 366	1 Oct	65.0	Recovered 13 Oct 70
Cosmos 367	3 Oct	65.3	In orbit
Cosmos 368	8 Oct	65.0	Recovered 14 Oct 70
Cosmos 369	8 Oct	71.0	Decayed 22 Jan 71
Cosmos 370	9 Oct	65.0	Recovered 22 Oct 70
Cosmos 371	12 Oct	74.0	In orbit

NAME	LAUNCH	INCLINATION	STATUS
1970 (Con't)			
Intercosmos 4	14 Oct	48.5	Decayed 17 Jan 71
Meteor 6	15 Oct	81.2	In orbit weather satellite
Cosmos 372	16 Oct	74.0	In orbit
Cosmos 373	20 Oct	62.9	In orbit
Zond 8	20 Oct	Circumlunar	Recovered 27 Oct 70; Indian Ocean
Cosmos 374	23 Oct	63.0	In orbit
Cosmos 375	30 Oct	63.0	In orbit
Cosmos 376	30 Oct	65.4	Recovered 12 Nov 70
Luna 17	10 Nov		Landed 17 Nov 70 - Sea of Rains - LUNOKHOD-I Lunar Rover
Cosmos 377	11 Nov	65.0	Recovered 23 Nov 70
Cosmos 378	17 Nov	74.0	In orbit
Cosmos 379	24 Nov	51.6	In orbit
Cosmos 380	24 Nov	82.0	Decayed 17 Jun 71
Molniya 1/16	27 Nov	65.3	In orbit - Communications Sat.
Cosmos 381	2 Dec	74.0	In orbit
Cosmos 382	2 Dec	51.6	In orbit
Cosmos 383	3 Dec	65.4	Recovered 16 Dec 70
Cosmos 384	10 Dec	72.9	Recovered 22 Dec 70
Cosmos 385	12 Dec	74.0	In orbit
Cosmos 386	15 Dec	65.0	Recovered 28 Dec 70
Cosmos 387	16 Dec	74.0	In orbit
Cosmos 388	18 Dec	71.0	Decayed 10 May 71
Cosmos 389	18 Dec	81.0	In orbit
Molniya 1/17	25 Dec	65.0	In orbit

1971			
Cosmos 390	12 Jan	65.0	Recovered 25 Jan 71
Cosmos 391	14 Jan	71.0	Decayed 21 Feb 72
Meteor 7	20 Jan	81.2	Meteorological Satellite
Cosmos 392	21 Jan	65.0	Recovered 2 Feb [illegible]
Cosmos 393	26 Jan	71.0	Decayed 16 Jun 71
Cosmos 394	10 Feb	65.9	In orbit
Cosmos 395	18 Feb	74.0	In orbit
Cosmos 396	18 Feb	65.4	Recovered 3 Mar 71
Cosmos 397	25 Feb	65.8	In orbit
Cosmos 398	26 Feb	51.63	In orbit
Cosmos 399	3 Mar	65.0	Recovered 17 Mar 71
Cosmos 400	18 Mar	65.8	In orbit
Cosmos 401	27 Mar	72.9	Recovered 9 Apr 71

1971 (Con't'd)			
Cosmos 411		74.5	In orbit
Cosmos 412		74.5	In orbit
Cosmos 413		74.5	In orbit
Cosmos 414		74.5	In orbit
Cosmos 415	7 May	74.5	In orbit
Cosmos 416		74.5	In orbit.
Cosmos 417		74.5	In orbit
Cosmos 418		74.5	In orbit
Cosmos 419	10 May	51.4	Decayed 12 May 71
Cosmos 420	18 May	51.8	Recovered 29 May 71
Cosmos 421	19 May	71.0	Decayed 8 Nov 71
Mars 2	19 May		Hard landed on Mars 27 Nov 71
Cosmos 422	21 May	74.0	In orbit

Cosmos 402	1 Apr	65.0	In orbit
Cosmos 403	2 Apr	81.4	Recovered 14 Apr 71
Cosmos 404	4 Apr	65.9	Decayed 4 Apr 71
Cosmos 405	7 Apr	81.3	In orbit
Cosmos 406	14 Apr	81.3	Recovered 24 Apr 71
Meteor 8	17 Apr	81.2	In orbit. Meteorological Sat.
Salyut-1	19 Apr	51.6	Decayed 11 Oct 71
Soyuz-10	22 Apr	52.0	Recovered 24 Apr 71
Cosmos 407	23 Apr	74.0	In orbit
Cosmos 408	24 Apr	82.0	Decayed 29 Dec 71
Cosmos 409	28 Apr	74.0	In orbit
Cosmos 410	6 May	65.0	Recovered 18 May 71

Cosmos 423	27 May	71.0	Decayed 26 Nov 71
Mars 3	28 May		Soft landed on Mars 2 Dec 71
Cosmos 424	28 May	65.4	Decayed 10 Jun 71
Cosmos 425	29 May	74.0	In orbit
Cosmos 426	5 Jun	74.0	In orbit
Soyuz 11	6 Jun		Manned: Georgiy Timofeyevich Dobrovolskiy, Vladislav Nikolayevich Volkov, Viktor Ivanovich Patsyev; Recovered 30 Jun 71; Cosmonauts expired.
Cosmos 427	11 Jun	72.9	Recovered 24 Jun 71
Cosmos 428	24 Jun	51.8	Recovered 6 Jul 71*

* Multiple Launch

1971 (Cont'd)			
Meteor 9	16 Jul	81.2	In orbit
Cosmos 429	20 Jul	51.8	Recovered 2 Aug 71
Cosmos 430	23 Jul	65.4	Recovered 5 Aug 71
Molniya 1/18	28 Jul	65.4	In orbit
Cosmos 431	30 Jul	51.8	Recovered 11 Aug 71
Cosmos 432	5 Aug	51.8	Recovered 18 Aug 71
Cosmos 433	8 Aug	49.5	Recovered 9 Aug 71
Cosmos 434	12 Aug	51.6	In orbit
Cosmos 435	27 Aug	71.0	Decayed 28 Jan 72
Luna 18	2 Sep	-	Impacted on moon 11 Sep 71
Cosmos 436	7 Sep	74.0	In orbit
Cosmos 437	10 Sep	74.0	In orbit
Cosmos 438	14 Sep	65.4	Recovered 27 Sep 71
Cosmos 439	21 Sep	65.4	Recovered 2 Oct 71
Cosmos 440	24 Sep	71.0	In orbit
Cosmos 441	28 Sep	65.0	Recovered 10 Oct 71
Luna 19	28 Sep	-	In lunar orbit
Cosmos 442	29 Sep	72.9	Recovered 12 Oct 71
Cosmos 443	7 Oct	65.4	Recovered 19 Oct 71
Cosmos 444			In orbit
Cosmos 445			In orbit
Cosmos 446			In orbit
Cosmos 447	13 Oct*	74.0	In orbit
Cosmos 448			In orbit
Cosmos 449			In orbit
Cosmos 450			In orbit
Cosmos 451			In orbit

* Multiple Launch

1971 (Cont'd)			
Cosmos 452	14 Oct	65.0	Recovered 27 Oct 71
Cosmos 453	19 Oct	71.0	Decayed 19 Mar 72
Cosmos 454	2 Nov	65.4	Recovered 16 Nov 71
Cosmos 455	17 Nov	71.0	Decayed 9 Apr 72
Cosmos 456	19 Nov	72.0	Recovered 2 Dec 71
Cosmos 457	20 Nov	74.0	In orbit
Molniya 2/1	25 Nov	65.4	In orbit, first of new communication satellite
Cosmos 458	29 Nov	71.0	Decayed 20 Apr 72
Cosmos 459	29 Nov	65.8	Decayed 27 Dec 71
Cosmos 460	30 Nov	74.0	In orbit
Intercosmos 5	2 Dec	48.4	In orbit, Joint USSR/Czechoslovakia
Cosmos 461	2 Dec	69.2	In orbit
Cosmos 462	3 Dec	65.8	In orbit
Cosmos 463	6 Dec	65 0	Recovered 11 Dec 71
Cosmos 464	10 Dec	72.9	Recovered 16 Dec 71
Cosmos 465	15 Dec	74.0	In orbit
Cosmos 466	16 Dec	65.0	Recovered 27 Dec 71
Cosmos 467	17 Dec	71.0	Decayed 18 Apr 72
Cosmos 468	17 Dec	74.0	In orbit
Molniya 1/19	20 Dec	65 5	In orbit
Cosmos 469	25 Dec	65.0	In orbit
Cosmos 470	27 Dec	65.4	Recovered 6 Jan 72
Oreol-1	27 Dec	74.0	In orbit, Joint USSR/France
Meteor 10	29 Dec	81.2	In orbit

UNOFFICIAL RECORD OF USSR MISSIONS

NAME	LAUNCH	INCLINATION	STATUS
1972			
Cosmos 471	12 Jan	65.0	Recovered 25 Jan 72
Cosmos 472	25 Jan	82.0	Decayed 18 Aug 72
Cosmos 473	3 Feb	65.0	Recovered 15 Feb 72
Luna 20	14 Feb	----	Soft landed on the moon on 21 Feb 72 in the Sea of Fertility. Returned to earth 25 Feb 72 with Lunar Rock Samples.
Cosmos 474	16 Feb	65.0	Recovered 29 Feb 72
Cosmos 475	25 Feb	74.0	In orbit
Cosmos 476	1 Mar	81.2	In orbit
Cosmos 477	4 Mar	72.9	Recovered 16 Mar 72
Cosmos 478	15 Mar	65.4	Recovered 28 Mar 72
Cosmos 479	23 Mar	74.0	In orbit
Cosmos 480	25 Mar	83.0	In orbit
Cosmos 481	25 Mar	74.0	Decayed 2 Sep 72
Venus 8	27 Mar		Soft landed Venus 22 Jul 72
Meteor 11	30 Mar	81.2	In orbit
Cosmos 482	31 Mar	52.0	In orbit
Cosmos 483	3 Apr	72.9	Recovered 15 Apr 72
Molniya 1/20 } *	4 Apr	65.6	In orbit
** SRET (French) }			
Cosmos 484	6 Apr	81.3	Recovered 18 Apr 72
Intercosmos 6	7 Apr	51.8	Recovered 11 Apr 72
Cosmos 485	11 Apr	71.0	Decayed 30 Aug 72
Cosmos 486	14 Apr	81.4	Recovered 27 Apr 72
PROGNOZ-1	14 Apr	65.0	In orbit (845 kg)

NAME	LAUNCH	INCLINATION	STATUS
1972 (cont'd)			
Cosmos 487	21 Apr	71.0	Decayed 24 Sep 72
Cosmos 488	5 May	65.4	Recovered 18 May 72
Cosmos 489	6 May	74.0	In orbit
Cosmos 490	17 May	65.4	Recovered 29 May 72
Molniya 2/2	19 May	65.5	In orbit
Cosmos 491	25 May	65.0	Recovered 8 Jun 72
Cosmos 492	9 Jun	65.0	Recovered 22 Jun 72
Cosmos 493	21 Jun	65.0	Recovered 3 Jul 72
Cosmos 494	23 Jun	74.0	In orbit
Cosmos 495	23 Jun	65.6	Recovered 6 Jul 72
Cosmos 496	26 Jun	51.6	Recovered 2 Jul 72
Prognoz 2	29 Jun	65.0	In orbit
Cosmos 497	30 Jun	71.0	In orbit
*Intercosmos 7	30 Jun	48.4	Decayed 5 Oct 72
Meteor 12	1 Jul	81.2	In orbit
Cosmos 498	5 Jul	71.0	Decayed 25 Nov 72
Cosmos 499	6 Jul	51.8	Recovered 17 Jul 72
Cosmos 500	11 Jul	74.0	In orbit
Cosmos 501	12 Jul	48.5	In orbit
Cosmos 502	13 Jul	65.4	Recovered 25 Jul 72
Cosmos 503	19 Jul	65.4	Recovered 1 Aug 72
Cosmos 504, Cosmos 505, Cosmos 506, Cosmos 507, Cosmos 508, Cosmos 509, Cosmos 510, Cosmos 511 ***	20 Jul	74.0	In orbit

* Dual launch ** USSR/France Cooperative (SRET) Satellite for Research & Technology - tests to study the degeneration caused in solar cells by cosmic rays *** Multiple Launch

1972 (cont'd)			
Cosmos 512	28 Jul	65.4	Recovered 9 Aug 72
Cosmos 513	2 Aug	65.0	Recovered 15 Aug 72
Cosmos 514	16 Aug	83.0	In orbit
Cosmos 515	18 Aug	72.9	Recovered 31 Aug 72
Cosmos 516	21 Aug	65.0	In orbit
Cosmos 517	30 Aug	65.0	Recovered 11 Sep 72
Cosmos 518	15 Sep	72.9	Recovered 24 Sep 72
Cosmos 519	16 Sep	71.3	Recovered 26 Sep 72
Cosmos 520	20 Sep	82.8	In orbit
Cosmos 521	29 Sep	65.8	In orbit
Molniya 2/3	30 Sep	65.3	In orbit
Cosmos 522	4 Oct	72.9	Recovered 17 Oct 72
Cosmos 523	5 Oct	71.0	In orbit
Cosmos 524	11 Oct	71.0	In orbit
Molniya 1/21	14 Oct	65.3	In orbit
Cosmos 525	18 Oct	65.4	Recovered 29 Oct 72
Cosmos 526	25 Oct	71.0	In orbit
Meteor 13	27 Oct	81.2	In orbit
Cosmos 527	31 Oct	65.4	Recovered 13 Nov 72
Cosmos 528			
Cosmos 529			
Cosmos 530			
Cosmos 531			
Cosmos 532	1 Nov	74.0	In orbit
Cosmos 533			
Cosmos 534			
Cosmos 535			
Cosmos 536	3 Nov	74.0	In orbit
Cosmos 537	25 Nov	65.0	Recovered 7 Dec 72
Intercosmos 8	30 Nov	71.0	In orbit
Molniya 1/22	2 Dec	65.0	In orbit
Molniya 2/4	12 Dec	65.3	In orbit
Cosmos 538	14 Dec	65.4	In orbit
Cosmos 539	21 Dec	74.0	In orbit
Cosmos 540	26 Dec	74.0	In orbit
Cosmos 541	27 Dec	81.4	In orbit
Cosmos 542	28 Dec	81.2	In orbit
1973			
Luna 21	8 Jan	60.0	Soft landed 16 Jan 73 Lunokhod-2 (Moon Car)
Cosmos 543	11 Jan	65.0	In orbit

SUMMARY OF SOVIET UNION MANNED SPACE FLIGHT

MISSION	NO. OF COSMONAUTS	MISSION DURATION	MAN-HOURS
VOSTOK:			
1	1	1:48	1 48
2	1	25:18	25 18
3	1	94 22	94 22
4	1	70 57	70.57
5	1	119·06	119 06
6	1	70·50	70 50
Total 6	6	382·21	382 21
VOSKHOD:			
1	3	24.17	72 51
2	2	26·02	52 04
Total 2	5	50·19	124 55
SOYUZ:			
1	1	26.37	26 37
3	1	94:51	94 51
* 4	1	71.23	71 23
	2	47 49	95 38
5	1	72·56	72 56
6	2	118 42	237:24
7	3	118 41	356 03
SOYUZ (Cont'd)			
8	2	118 50	237 40
9	2	424 59	849 58
10	3	47 46	143 18
11	3	570 22	1711·06
Total 10	21	1712.56	3896 54
USSR TOTAL 18	32	2145 36	4404 10

* Soyuz 4 launched 1 Cosmonaut and docked with Soyuz 5 carrying 3 Cosmonauts. Soyuz 4 returned with 3 Cosmonauts, 2 of which were transferred from Soyuz 5.

SOURCE:
NASA-Program and Special Reports Division
CONGRESSIONAL RECORD-Soviet Space Programs (Supplement) Apr 72

USSR COSMONAUTS COMPARATIVE TIME SPENT ON SPACE MISSIONS

COSMONAUTS	FLIGHTS	HRS., MINS.	MISSION
Volkov	2	689.03	Soyuz 7, Soyuz 11
Dobrovolskiy	1	570 22	Soyuz 11
Potsayev	1	570.22	Soyuz 11
Nikolayev	2	519:22	Vostok 3, Soyuz 9
Sevastyanov	1	424 59	Soyuz 9
Shatalov	3	237.59	Soyuz 4, Soyuz 8, Soyuz 10
Yeliseyev	3	214·24	Soyuz 5, Soyuz 8, Soyuz 10
Bykovsky	1	119.06	Vostok 5
Shonin	1	118 42	Soyuz 6
Kubasov	1	118.42	Soyuz 6
Filipchencko	1	118·41	Soyuz 7
Gorbatko	1	118:41	Soyuz 7
Beregovoy	1	94:51	Soyuz 3
Volynov	1	72:56	Soyuz 5
Popovich	1	70:57	Vostok 4
Tereshkova	1	70.50	Vostok 6
Komarov	2	50:54	Voskhod 1, Soyuz 1
Khrunov	1	47·49	Soyuz 5
Rukavishnikov	1	47.46	Soyuz 10
Belyayev	1	26 02	Voskhod 2
Leonov	1	26:02	Voskhod 2
Titov	1	25 18	Vostok 2
Yegorov	1	24:17	Voskhod 1
Feoktistov	1	24.17	Voskhod 1
Gagarin	1	1 48	Vostok 1
TOTAL	32	4,404 10	18

SOVIET UNION FLIGHT SUMMARY

	2 MEN (3 Flights)	6
	3 MEN (2 Flights)	6
	20 MEN (1 Flight)	20
TOTAL	25 MEN	32

SOURCE NASA - Program and Special Reports Division
Congressional Record - Soviet Space Programs (Supplement) Apr 72

APPENDIX B

SUMMARY RECORD OF MAJOR SPACE 'FIRSTS'

SUMMARY RECORD OF MAJOR SPACE 'FIRSTS'

UNITED STATES				UNION OF SOVIET SOCIALIST REPUBLICS			
EVENT	MISSION	LAUNCH DATE	EVENT DATE	EVENT	MISSION	LAUNCH DATE	EVENT DATE
BIO AND MANNED FLIGHT							
Manned orbital maneuver	Gemini III	23 Mar 65	23 Mar 65	Biosatellite	Sputnik II	3 Nov 57	*10 Nov 57
Manned space rendezvous	Gemini VIA, VII	4 Dec 65	4 Dec 65	Recovery of orbited animals	Sputnik V	19 Aug 60	20 Aug 60
Manned docking of two craft	Gemini VIII-Agena	16 Mar 66	16 Mar 66	Manned flight and recovery	Vostok I	12 Apr 61	12 Apr 61
Manned lunar orbit	Apollo 8	21 Dec 68	24 Dec 68	Multi-manned spacecraft	Voskhod I	12 Oct 64	13 Oct 64
Manned lunar orbit rendezvous	Apollo 10	18 May 69	22 May 69	Recovery, circumlunar, live animals	Zond V	14 Sep 68	21 Sep 68
Manned lunar landing	Apollo 11	16 Jul 69	20 Jul 69	Manned transfer between spacecraft	Soyuz IV	14 Jan 69	16 Jan 69
					Soyuz V	15 Jan 69	16 Jan 69
				18-day manned flight	Soyuz IX	1 Jun 70	19 Jun 70
				Manned orbital scientific station	Soyuz XI	6 Jun 71	30 Jun 71
MANNED EXTRAVEHICULAR ACTIVITY							
Controlled EVA	Gemini IV	3 Jun 65	3 Jun 65	LEONOV, (10 minutes)	Voskhod II	18 Mar 65	18 Mar 65
Manned (LRV) Lunar Roving Vehicle on Lunar Surface	Apollo 15	26 Jul 71	31 Jul 71				

*Last Transmission Date

SUMMARY RECORD OF MAJOR SPACE 'FIRSTS'

SCIENCE

UNITED STATES

EVENT	MISSION	LAUNCH DATE	EVENT DATE
Van Allen Radiation Belts	Explorer I	1 Feb 58	*23 May 68
Earth shape measured	Vanguard I	17 Mar 58	*May 64
Orbiting solar observatory	OSO-I	7 Mar 62	*6 Aug 63
Data from Venus	Mariner II	27 Aug 62	14 Dec 62
Geodetic satellite	Anna IB	31 Oct 62	31 Oct 62
Lunar close-up pictures	Ranger VII	28 Jul 64	31 Jul 64
Mars pictures	Mariner IV	28 Nov 64	14 Jul 65
Micrometeorite satellite	Pegasus I	16 Feb 65	*29 Aug 68
Controlled soft landing on moon	Surveyor I	30 May 66	2 Jun 66
Lunar orbit pictures	Orbiter I	10 Aug 66	*29 Oct 66
Lunar trenching	Surveyor III	17 Apr 67	20 Apr 67
Photos of eclipse of sun & earth in color	Surveyor III	17 Apr 67	4 May 67
Color picture of full earth face	Dodge	1 Jul 67	1 Jul 67
Lunar soil chemical analysis	Surveyor V	8 Sep 67	11 Sep 67
Pointed-stabilized OAO	OAO-II	7 Dec 68	7 Dec 68
Live lunar TV broadcast	Apollo 8	21 Dec 68	24 Dec 68
Return of lunar rocks	Apollo 11	16 Jul 69	24 Jul 69
Long life lunar surface sensors	Apollo 12	14 Nov 69	19 Nov 69
Orbiting X-ray satellite	Exp 42 (SAS-A)	12 Dec 70	12 Dec 70
EVA from CM during transearth coast	Apollo 15	26 Jul 71	5 Aug 71
Spacecraft to orbit another planet (Mars)	Mariner 9	30 May 71	13 Nov 71
Landing in & exploring lunar highlands	Apollo 16	16 Apr 72	20 Apr 72
Cosmic Ray Detector deployed on lunar surface	Apollo 16	16 Apr 72	21 Apr 72
Spacecraft entered the Asteroid Belt	Pioneer 10	3 Mar 72	15 Jul 72
Scientific telescope in orbit	OAO-C	21 Aug 72	21 Aug 72
Geologist Astronaut on lunar surface	Apollo 17	7 Dec 72	11 Dec 72

UNION OF SOVIET SOCIALIST REPUBLICS

EVENT	MISSION	LAUNCH DATE	EVENT DATE
Orbiting geophysical Lab	Sputnik III	15 May 58	*6 Apr 60
Farside lunar picture	Luna III	4 Oct 59	*7 Oct 59
Cosmic ray measurements	Proton I	16 Jul 65	*11 Oct 65
Lunar surface pictures	Luna IX	31 Jan 66	4 Feb 66
Lunar surface bearing test	Luna XIII	21 Dec 66	26 Dec 66
Venus atmospheric entry probe	Venera IV	12 Jun 67	18 Oct 67
Unmanned lunar landing and return	Luna XVI	12 Sep 70	24 Sep 70
Unmanned (Lunokhod-1) (Landing of moon vehicle in the Sea of Rains)	Luna XVII	10 Nov 70	17 Nov 70
Lasted 10½ months, completed functioning on 4 Oct 71			
Distance covered 10 54 meters			
Hard landing of unmanned capsule on Martian surface	Mars 2	19 May 71	27 Nov 71
Soft landing of unmanned capsule on Martian surface	Mars 3	28 May 71	2 Dec 71

* Last Transmission Date

SUMMARY RECORD OF MAJOR SPACE 'FIRSTS'

UNITED STATES				UNION OF SOVIET SOCIALIST REPUBLICS			
EVENT	MISSION	LAUNCH DATE	EVENT DATE	EVENT	MISSION	LAUNCH DATE	EVENT DATE
AUXILIARY POWER SYSTEMS							
Solar cells on craft	Vanguard I	17 Mar 58	*May 64	Battery powered spacecraft	Sputnik I	4 Oct 57	*25 Oct 57
Isotope power on craft	Transit IVA	29 Jun 61	29 Jun 61				
Nuclear energy powered craft	Transit VBNI	28 Sep 63	28 Sep 63				
Nuclear reactor in orbit	Snapshot I	3 Apr 65	*16 May 65				
Fuel cell use in space	Gemini V	21 Aug 65	21 Aug 65				
SPACE FLIGHT AND PROPULSION							
Multiple payloads and orbits	Transit/Solrad	22 Jun 60	Aug 62/Apr 61	World's First Satellite	Sputnik I	4 Oct 57	*25 Oct 57
Payload recovery	Discoverer XIII	10 Aug 60	14 Nov 60	Earth escape spacecraft	Luna I	2 Jan 59	2 Jan 59
Air snatch payload recovery	Discoverer XIV	18 Aug 60	16 Sep 60	Lunar impact	Luna II	12 Sep 59	14 Sep 59
Synchronous satellite	Syncom II	26 Jul 63	26 Jul 63	Mars flyby	Mars I	1 Nov 62	Apr 62
Hydrogen-fueled rocket orbited	Centaur II	27 Nov 63	27 Nov 63	Venus impact	Venera III	16 Nov 65	1 Mar 66
Docked spacecraft maneuver	Gemini X-Agena	18 Jul 66	18 Jul 66	Luna soft landing	Luna IX	31 Jan 66	3 Feb 66
Lunar lift-off	Surveyor VI	7 Nov 67	10 Nov 67	Luna Orbiter	Luna X	31 Mar 66	*4 Apr 66
Lunar-return velocity reentry	Apollo 4	9 Nov 67	9 Nov 67	Venus soft landing	Venera IV	12 Jun 67	18 Oct 67
Constant Deceleration Reentry	Apollo 8	21 Dec 68	27 Dec 68	Automatic docking	Cosmos 186 188	27-30 Oct 67	30 Oct 67
Pin point lunar landing capability	Apollo 12	14 Nov 69	19 Nov 69	Circumlunar flight recovery	Zond V	14 Sep 68	21 Sep 68
Highest velocity launch for interplanetary spaceflight	Pioneer 10	3 Mar 72	3 Mar 72	Skip reentry lunar payload	Zond VI	10 Nov 68	17 Nov 68
Dependence of use of radioisotope thermalelectric generator for primary electrical power	Pioneer 10	3 Mar 72	3 Mar 72				

*Last Transmission Date

SUMMARY RECORD OF MAJOR SPACE 'FIRSTS'

UNITED STATES				UNION OF SOVIET SOCIALIST REPUBLICS			
EVENT	MISSION	LAUNCH DATE	EVENT DATE	EVENT	MISSION	LAUNCH DATE	EVENT DATE
APPLICATIONS							
Active communications	Score	18 Dec 58	*31 Dec 58				
Earth photo from space	Explorer VI	7 Aug 59	*7 Aug 59				
Global weather cover photo	Tiros I	1 Apr 60	*17 Jun 60				
Navigation satellite	Transit 1B	13 Apr 60	*12 Jul 60				
Missile detection	Midas II	24 May 60	*26 May 60				
Passive communications	Echo I	12 Aug 60	*24 May 68				
Nuclear explosion detection	Vela Hotel	17 Oct 63	22 Oct 63				
Atmospheric Structure determination	Nimbus III	14 Apr 69	14 Apr 69				
Color TV of lunar EVA	Apollo 15	26 Jul 71	31 Jul 71				
Use of ground controlled remote operation of TV camera on the moon	Apollo 15	26 Jul 71	2 Aug 71				
Subsatellite launched in lunar orbit	Apollo 15	26 Jul 71	4 Aug 71				
Earth resources technology sat	ERTS-A	23 Jul 72	23 Jul 72				
Repetitive multi-spectral imaging of earth surface	ERTS-A	23 Jul 72	23 Jul 72				

*Last Transmission Date

APPENDIX C

OUTER SPACE TREATY - 1967

Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies

The States Parties to this Treaty,

Inspired by the great prospects opening up before mankind as a result of man's entry into outer space.

Recognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes.

Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development.

Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes.

Believing that such co-operation will continue to the development of mutual understanding and to the strengthening of friendly relations between States and peoples.

Recalling resolution 1962 (XVIII), entitled "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space", which was adopted unanimously by the United Nations General Assembly on 13 December 1963.

Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963.

Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space.

Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,

Have agreed on the following:

ARTICLE I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Outer space, including the moon and other celetial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

ARTICLE II

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

ARTICLE III

State Parties to the Treaty shall carry on activities in the exploration and use of outer space including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international co-operation and understanding.

ARTICLE IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

The moon and other celestial bodies shall be used by all States Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies shall also not be prohibited.

ARTICLE V

States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas. When astronauts make such a landing, they shall be safely and promptly returned to the State of registry of their space vehicle.

In carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties.

States Parties to the Treaty shall immediately inform the other States Parties to the Treaty or the Secretary-General of the United Nations of any phenomena they discover in outer space, including the moon and other celestial bodies, which could constitute a danger to the life or health of astronauts.

ARTICLE VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

ARTICLE VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.

ARTICLE VIII

A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

ARTICLE IX

In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or equipment.

ARTICLE X

In order to promote international co-operation in the exploration and use of outer space, including the moon and other celestial bodies, in conformity with the purposes of this Treaty, the States Parties to the Treaty shall consider on a basis of the equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

ARTICLE XI

In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.

ARTICLE XII

All stations, installations, equipment and space vehicles on the moon and other celestial bodies shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity. Such representatives shall give reasonable advance notice of a projected visit, in order that appropriate consultations may be held and that maximum precautions may be taken to assure safety and to avoid interference with normal operations in the facility to be visited.

ARTICLE XIII

The provisions of this Treaty shall apply to the activities of States Parties to the Treaty in the exploration and use of outer space, including the moon and other celestial bodies, whether such activities are carried on by a single State Party to the Treaty or jointly with other States, including cases where they are carried on within the framework of international inter-governmental organizations.

Any practical questions arising in connection with activities carried on by international inter-governmental organizations in the exploration and use of outer space, including the moon and other celestial bodies, shall be resolved by the States Parties to the Treaty either with the appropriate international organization or with one or more States members of that international organization, which are Parties to this Treaty.

ARTICLE XIV

1. This Treaty shall be open to all States for signature. Any State which does not sign this Treaty before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Treaty shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics, which are hereby designated the Depositary Governments.

3. This Treaty shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Treaty.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Treaty, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Treaty, the date of its entry into force and other notices.

6. This Treaty shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

ARTICLE XV

Any State Party to the Treaty may propose amendments to this Treaty. Amendments shall enter into force for each State Party to the Treaty accepting the amendments upon their acceptance by a majority of the States Parties to the Treaty and thereafter for each remaining State Party to the Treaty on the date of acceptance by it.

ARTICLE XVI

Any State Party to the Treaty may give notice of its withdrawal from the Treaty one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

ARTICLE XVII

This Treaty, of which the English, Russian, French, Spanish and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Treaty shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

In witness whereof the undersigned duly authorized, have signed this Treaty.

Done in triplicate, at the cities of Washington, London and Moscow, this twenty-seventh day of January one thousand nine hundred sixty-seven.

For the United States of America:
DEAN RUSK
ARTHUR J. GOLDBERG
For the United Kingrom of Great Britain and Northern Ireland:
PATRICK DEAN
For the Union of Soviet Socialist Republics:
A. F. DOBRYNIN
For Chile:
RADOMIRO TOMIC
For Mexico:
HUGO B. MARGAIN
For China:
CHOW SHU-KAI
For Italy:
SERGIO FENOALTEA
For Honduras:
RICARDO MIDENCE SOTO
For Ethiopia:
TASHOMA HAILE-MARIAM
For Ghana:
ABRAHAM BENJAMIN BAH KOFI
For Cyprus:
ZENON ROSSIDES
For Canada:
A. EDGAR RITCHIE
For Bulgaria:
DR. LUBEN GUERASSIMOV
For Australia:
JOHN KEITH WALLER
For Denmark:
FLEMMING AGERUP
For Hungary
JANOS RADVANYI
For Iceland:
PETUR THORSTEINSSON
For Czechoslovakia:
DR. KAREL DUDA

For Japan:
RYUJI TAKEUCHI
For Romania:
PETRE BALACEANU
For Poland:
ZDZISLAW SZEWCZYK
For Tunisia:
RACHID DRISS
For New Zealand:
JACK SHEPHERD
For Colombia:
HEBNAN ECHAVARRIA OLOZAGA
For Finland:
OLAVI MUNKKI
For Panama:
RICARDO M. ARIAS E.
For Laos:
KHAMKING SOUVANLASY
For Greece:
ALEXANDER A. MATSAS
For the Philippines:
JOSE F. IMPERIAL
For Turkey:
MELIH ESENBEL
For Yugoslavia:
VELJKO MICUNOVIC
For Afghanistan:
DR. ABDUL MAJID
For Argentina:
ALVARO C. ALSOGARAY
For the United Arab Republic
MOSTAFA KAMEL
For Haiti:
ARTHUR BONHOMME
For Luxembourg:
MAURICE STEINMETZ
For Viet-Nam:
BUI DIEM

For Venezuela:
ENRIQUE TEJERA-PARIS

For the Federal Republic of Germany:
HEINRICH KNAPPSTEIN

For Israel:
AVRAHAM HARMAN

For El Salvador:
RAMON DE CLAIRMONT-DUENAS

For Thailand:
SUKICH NIMMANHEMINDA

For Sweden:
HUBERT DE BESCHE

For Ecuador:
GUSTAVJ LARREA

For Togo:
ROBERT AJAVON

For the Dominican Republic:
HÉCTOR GARCIA-GODOY

For Switzerland:
FELIX SCHNYDER

For Burundi:
CLEMENT SAMBIRA

For Ireland:
WILLIAM P. FAY

For Cameroon:
JOSEPH N. OWONO

For Indonesia:
SUWITO KUSUMOWIDAGDO

For Bolivia:
JULIO SANJINES-GOYTIA

For Botswana:
ZACHARIAH KEQDIRELANG MATTHEWS

For Lesotho:
ALBERTO S. MOHALE

For Korea:
HYUN CHUL KIM

For the Congo (Kinshasa):
CYRILLE ADOULA

For Uruguay:
RUBIN A. ALEJANDRO CHELLE
For the Central African Republic:
MICHEL GALLIN-DOUATHE
For Rwanda:
CELESTIN KABANDA
For Nicaragua:
GUILLERMO SEVILLA-SACASA

APPENDIX D

RESCUE AND RETURN AGREEMENT, 1968

Agreement on the rescue of astronauts, the return of Astronaults and the return of objects launched into outer space

The Contracting Parties,

Noting the great importance of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies which calls for the rendering of all possible assistance to astronauts in the event of accident, distress or emergency landing, the prompt and safe return of astronauts, and the return of objects launched into outer space.

Desiring to develop and give further concrete expression to these duties,

Wishing to promote international co-operation in the peaceful exploration and use of outer space,

Prompted by sentiments of humanity,

Have Agreed on the following:

ARTICLE 1

Each Contracting Party which receives information or discovers that the personnel of a spacecraft have suffered accident or are experiencing conditions of distress or have made an emergency or unintended landing in territory under its jurisdiction or on the high seas or in any other place not under the jurisdiction of any State shall immediately:

(a) Notify the launching authority or, if it cannot identify and immediately communicate with the launching authority, immediately make a public announcement by all appropriate means of communication at its disposal:

(b) Notify the Secretary-General of the United Nations, who should disseminate the information without delay by all appropriate means of communication at his disposal.

ARTICLE 2

If, owing to accident, distress, emergency or unintented landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party, it shall immediately take all possible steps to rescue them and render them all necessary assistance. It shall inform the launching authority and also the Secretary-General of the United Nations of the steps it is taking and of their progress. If assistance by the launching authority would help to effect a prompt rescue or would contribute substantially to the effectiveness of search and rescue operations, the launching authority shall co-operate with the Contracting Party with a view to the effective conduct of search and rescue operations. Such operations shall be subject to the direction and control of the Contracting Party, which shall act in close and continuing consultation with the launching authority.

ARTICLE 3

If information is received or it is discovered that the personnel of a spacecraft have alighted on the high seas or in any other place not under the jurisdiction of any State, those Contracting Parties which are in a position to do so shall, if necessary, extend assistance in search and rescue operations for such personnel to assure their speedy rescue. They shall inform the launching authority and the Secretary-General of the United Nations of the steps they are taking and of their progress.

ARTICLE 4

If, owing to accident, distress, emergency or unintended landing, the personnel of a spacecraft land in territory under the jurisdiction of a Contracting Party or have been found on the high seas or in any other place not under the jurisdiction of any State, they shall be safely and promptly returned to representatives of the launching authority.

ARTICLE 5

1. Each Contracting Party which receives information or discovers that a space object or its component parts has returned to Earth in territory under its jurisdiction or on the high seas or in any other place not under the jurisdiction of any State, shall notify the launching authority and the Secretary-General of the United Nations.

2. Each Contracting Party having jurisdiction over the territory on which a space object or its component parts has been discovered shall, upon the request of the launching authority and with assistance from that authority if requested, take such steps as it finds practicable to recover the object or component parts.

3. Upon request of the launching authority, objects launched into outer space or their component parts found beyond the territorial limits of the launching authority shall be returned to or held at the disposal of representatives of the launching authority, which shall, upon request, furnish identifying data prior to their return.

4. Notwithstanding paragraphs 2 and 3 of this article, a Contracting Party which has reason to believe that a space object or its component parts discovered in territory under its jurisdiction, or recovered by it elsewhere, is of a hazardous or deleterious nature may so notify the launching authority, which shall immediately take effective steps, under the direction and control of the said Contracting Party, to eliminate possible danger or harm.

5. Expenses incurred in fulfilling obligations to recover and return a space object or its component parts under paragraphs 2 and 3 of this article shall be borne by the launching authority.

ARTICLE 6

For the purposes of this Agreement, the term "launching authority" shall refer to the State responsible for launching, or, where an international inter-governmental organization is responsible for launching, that organization, provided that that organization declares its acceptance of the rights and obligations provided for in this Agreement and a majority of the States members of that organization are Contracting Parties to this Agreement and to the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies.

ARTICLE 7

1. This Agreement shall be open to all States for signature. Any State which does not sign this Agreement before its entry into force in accordance with paragraph 3 of this article may accede to it at any time.

2. This Agreement shall be subject to ratification by signatory States. Instruments of ratification and instruments of accession shall be deposited with the Governments of the United States of America, the United Kingdom of Great Britain and Northern Ireland and the Union of Soviet Socialist Republics which are hereby designated the Depositary Governments.

3. This Agreement shall enter into force upon the deposit of instruments of ratification by five Governments including the Governments designated as Depositary Governments under this Agreement.

4. For States whose instruments of ratification or accession are deposited subsequent to the entry into force of this Agreement, it shall enter into force on the date of the deposit of their instruments of ratification or accession.

5. The Depositary Governments shall promptly inform all signatory and acceding States of the date of each signature, the date of deposit of each instrument of ratification of and accession to this Agreement, the date of its entry into force and other notices.

6. This Agreement shall be registered by the Depositary Governments pursuant to Article 102 of the Charter of the United Nations.

ARTICLE 8

Any State Party to the Agreement may propose amendments to this Agreement. Amendments shall enter force for each State Party to the Agreement accepting the amendments upon their acceptance by a majority of the States Parties to the Agreement and thereafter for each remaining State Party to the Agreement on the date of acceptance by it.

ARTICLE 9

Any State Party to the Agreement may give notice of its withdrawal from the Agreement one year after its entry into force by written notification to the Depositary Governments. Such withdrawal shall take effect one year from the date of receipt of this notification.

ARTICLE 10

This Agreement, of which the English, Russian, French, Spanish, and Chinese texts are equally authentic, shall be deposited in the archives of the Depositary Governments. Duly certified copies of this Agreement shall be transmitted by the Depositary Governments to the Governments of the signatory and acceding States.

IN WITNESS WHEREOF the undersigned, duly authorized, have signed this Treaty.

Done in triplicate, at the cities of Washington, London and Moscow, this twenty-second day of April one thousand nine hundred sixty-eight.

APPENDIX E

US/USSR SPACE AGREEMENT

Text of the agreement on cooperation in space between the United States andthe Union of Soviet Socialist Republics signed in Moscow on May 24, 1972:

AGREEMENT

Between the United States of America and the Union of Soviet Socialist Republics concerning cooperation in the exploration and use of outer space for peaceful purposes.

The United States of America and the Union of Soviet Socialist Republics,

Considering the role which the USA and the USSR play in the exploration and use of outer space for peaceful purposes.

Striving for a further expansion of cooperation between the USA and the USSR in the exploration and use of outer space for peaceful purposes.

Noting the positive cooperation which the parties have already experienced in this area.

Desiring to make the results of scientific research gained from the exploration and use of outer-space for peaceful purposes available for the benefit of the peoples of the two countries and of all peoples of the world.

Taking into consideration the provisions of the treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies, as well as the agreement on the rescue of astronauts, the return of astronauts, and the return of objects launched into outer space.

In accordance with the agreement between the United States of America and the Union of Soviet Socialist Republics of exchanges and cooperation in scientific, technical, educational, cultural, and other fields, signed April 11, 1972, and in order to develop further the principles of mutually beneficial cooperation between the two countries:

Have agreed as follows:

ARTICLE 1

The parties will develop cooperation in the fields of space meteorology. study of the natural environment. the exploration of near-Earth space, the moon and the planets: and space biology and medicine: and in particular will cooperate to take all appropriate measures to encourage and achieve the fulfillment of the "summary of results of discussions on space cooperation between the US National Aeronautics and Space Administration and the Academy of Sciences of the USSR" of January 21, 1971.

ARTICLE 2

The parties will carry out such cooperation by means of mutual exchanges of scientific information and delegations, through meetings of scientists and specialists of both countries, and also in such other ways as may be mutually agreed. Joint working groups may be created for the development and implementation of appropriate programs of cooperation.

ARTICLE 3

The parties have agreed to carry out projects for developing compatible rendezvous and docking systems of United States and Soviet manned spacecraft and stations in order to enhance the safety of manned flight in space and to provide the opportunity for conducting joint scientific experiments in the future. It is planned that the first experimental flight to test these systems be conducted during 1975, envisaging the docking of a US Apollo-type spacecraft and a Soviet Soyuz-type spacecraft with visits of astronauts in each other's spacecrafts. The implementation of these projects will be carried out on the basis of principles and procedures which will be developed in accordance with the summary of results of the meeting between representatives of the US National Aeronautics and Space Administration and the USSR Academy of Sciences on the question of developing compatible systems for rendezvous and docking of manned spacecraft and space stations of the USA and USSR, dated April 6, 1972.

ARTICLE 4

The parties will encourage international efforts to resolve problems of international law in the exploration and use of outer space for peaceful purposes with the aim of strengthening the legal order in space and further developing international space law and will cooperate in this field.

ARTICLE 5

The parties may by mutual agreement determine other areas of cooperation in the exploration and use of outer space for peaceful purposes.

ARTICLE 6

This agreement shall enter into force upon signature and shall remain in force for five years. It may be modified or extended by mutual agreement of the parties.

Done at Moscow on the 24th of May, 1972, in duplicate in the English and Russian languages, each equally authentic.

For the United States of America
Richard Nixon
For the Union of
Soviet Socialist Republics
Aleksei N. Kosygin

INDEX

The following is a list of subjects of interest to the study of space technology, including many of the terms listed in the "Words and Phrases to Remember" sections at the end of each chapter, plus other entries. Terms in this list are adequately explained in the text, usually where first mentioned. Page references locate passages where the items are defined, discussed, or explained, as necessary.

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AIR FORCE J.R.O.T.C.