TRANSLATION

FIVE YEARS OF SOVIET SPACE INVESTIGATION

By

M. G. Kroshkin and V. G. Samarin

FOREIGN TECHNOLOGY DIVISION

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TRANSLATION DIVISION
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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

FOLLOWING ARE THE CORRESPONDING RUSSIAN AND ENGLISH

DESIGNATIONS OF THE TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}
rot	curl
lg	log

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FIVE YEARS OF SOVIET SPACE INVESTIGATION

M. G. Kroshkin and V. G. Samarin

This survey is a short reference of the basic stages of space investigations carried out in the Soviet Union during the five years (1958-1962) of the "space era." Data are given on all Soviet spacecraft launched in 1957-1962 (Tables 1-5).

On 4 October 1957 the Soviet Union launched the first artificial earth satellite, in a month, the second, and in May 1958, the third.

All of them were launched for geophysical purposes according to the program of the International Geophysical Year (IGY), 1957-1958. The launching of satellites, along with wide development of rocket investigations, gave special value to the research in the program of the IGY: this was the first possibility to obtain direct experimental data about the upper atmosphere, shortwave and corpuscular solar radiations, primary cosmic ray, meteor substance, etc.

The first satellite allowed us to obtain data on the density of the upper atmosphere and the properties of the ionosphere, and also on the temperature regime of artificial satellites when they are moving in orbit in outer space. This had direct geophysical value and was a necessary stage for transition to further investigations. The next launching had an even wider program of investigations; it also included a biological experiment. The third satellite, having a gigantic weight (1327 kg) even by contemporary standards, was essentially a unique laboratory in space, which allowed Soviet scientists to directly investigate all the complex program of the IGY more exactly on the very subjects assigned to satellites.

The following stage of space investigations was the launching in 1959 of three

space rockets. The first, studied the space enviroments of Earth and Moon and became the first artifical planet of the solar system. The second, reached the Moon and investigated cosmic space while on route from Earth to the Moon. The third launching, placed the first robot space station in a complicated orbit; along with carrying out of different physical investigations, this RSS photographed the reverse side of the Moon and automatically transmitted the image of the Moon to Earth, an achievement which has not been repeated even after more than three years from its accomplishment.

In 1960 the preparation for the space flight of a man was widely developed. Ship-satellites were launched one after another; technical systems and different stages of flight were developed; and the effect of specific conditions of space flight on living organisms was checked by direct experiments with animals.

It is necessary to note that in this scientific data of exceptionally great geophysical interest were obtained. This pertains first of all to the investigation of the structure of the lower region of radiation zones. It turned out that they not only have asymmetry with respect to the form of the Earth (i.e., the terrestrial "sphere") due to the noncoincidence of the magnetic dipole with the center of the Earth, but they also change their configuration in regions of anomalies of the Earth's magnetic field. As it turned out, in the region of the Brazilian anomaly, located in the Southern Atlantic, near the shores of Brazil, spurs of the radiation belt approach to within 300 km of the Earth.

In 1961 the first launching of a robot space station to the planet Venus was carried out; two experimental ship-satellites were launched, and, most important, the first flights of Soviet astronauts Yuriy Alekseyevich Gagarin and German Stepanovich Titov were accomplished.

The great achievement of Soviet science and technology in 1962 was the several-day group flight around the Earth by Andrian Grigor'yevich Nikolayev and Pavel Romanovich Popovich on spaceships-satellites Vostok 3 and Vostok 4. On 1 November 1962 the robot space station Mars-1 was the first to be launched to the planet Mars in accordance with the program, carried out in Soviet Union of research of space and the planets of the solar system.

On 16 March 1962 TASS declared that the Soviet Union had launched artificial earth satellites of the Cosmos series in accordance with a wide program of scientific research of the upper-atmosphere and cosmic space. This program was designed to

carry out the following scientific investigations:

1) a study of the concentration of charged particles in the ionosphere to investigate the propagation of radio waves;

2) a study of corpuscular streams and particles of low energies;

3) study of the energy composition of radiation belts of Earth to evaluate the radiation hazard during prolonged space flights;

4) a study of the primary composition of cosmic rays and variations in their intensity;

5) a study of the Earth's magnetic field;

6) a study of shortwave solar radiation and other space bodies;

7) a study of the upper layers of the atmosphere;

8) a study of the influence of meteoric substance on elements of construction of objects in outer space;

9) a study of the distribution and formation of cloud systems in the Earth's atmosphere.

Furthermore, many elements of constructions of spacecraft had to be developed. In 1962 12 Cosmos satellites were launched (see Table 5).

There are broad prospects of space investigations, both geophysical, and astronomical, in front of scientists. Much of value will be forthcoming in 1964-1965 from the research in the program of the International Year of the Quiet Sun (IYQS). It is possible to consider that investigation with help of rockets and satellites will play an even greater role than during the IGY.

In a brief survey article it is difficult to enumerate all the results obtained with the help of artificial earth satellites during the IGY. They are published in different scientific publications. There is a list below of the basic literature containing official materials about the launchings of Soviet spacecraft, flights of Soviet astronauts and the basic results of investigations attained in the Soviet Union with the help of rockets and satellites. Additional information about the literature on investigations with the help of rockets and satellites can be found in works [33, 34].

The basic information about the spacecraft launched by the Soviet Union in 1957-1962 is given in Tables 1-5.

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SOVIET ARTIFICIAL EARTH SATELLITES, SPACE ROCKETS, ROBOT SPACE STATIONS AND SPACESHIP-SATELLITES (1957-1962)

Table 1. Artificial Earth Satellites (AES)

Name and accepted international designation	Launch date	Weight, kg	Initial orbital data				Duration of existence (flight), days	Number of turns around the Earth	Distance travelled, million, km
			perigee, km	apogee, km	period of rotation around the Earth, min	angle of inclination of orbital plane to the plane of the Earth's equator			
First Artificial Earth Satellite AES[1] 1957-α	4 October 1957	83.6	228	947	96.17	65°.1	92	About 1400	About 60
Second Artificial Earth Satellite AES[2] 1957-β	3 November 1957	508.3 (weight of equipment, experimental animal and power sources)	225	1671	103.75	65.3	163	About 2370	More than 100
Third Artificial Earth Satellite AES[3] 1958-δ	15 May 1958	1327 (968 kg is the weight of scientific and radio measuring equipment and power sources).	226	1881	105.95	65.2	691	10,037	More than 448
Heavy Artificial Earth Satellite AES[4] 1961-β	4 February 1961	6483 (without counting the weight of last stage of the carrier rocket).	223.5	327.6	89.8	64.57	To 26 February 1961	—	—
Heavy Artificial Earth Satellite AES[5] 1961-γ	12 February 1961	—	222	280	89.6	65°	To 25 February 1961	—	—
Heavy Artificial Earth Satellite AES[6] 1962-βν	1 November 1962	—	—	—	—	—	—	—	—

Footnotes to Table 1.

[1]This satellite was launched according to the program of the International Geophysical Year (IGY); it was designed to carry out scientific research of the upper atmosphere and outer space near Earth. The experiments on the satellite included: 1) measurement of temperature and pressure inside the spherical body of the satellite (diameter 58 cm); 2) adjustment of temperature regime inside the satellite by changing the forced circulation of gaseous nitrogen (depending upon temperature); 3) determination of the density of the upper atmospheric layers (from the braking of motion of the satellite); 4) ionospheric investigation (from observation of propagation of radio waves, radiated from the satellite).

The frequency of the two radio transmitters was 20.005 and 40.002 Mc. (the wavelengths were about 15 and 7.5 m respectively) for a duration of radio signals, in the form of telegraph messages, of abo.. 2.3 sec with a pause of the same duration. The signal on one frequency was sent during the pause of the signal on the other frequency.

This was the first artificial Earth satellite, the first artificial body created by human hands and launched into space.

On 4 January 1958 it entered the dense layers of the atmosphere and ceased to exist.

[2]This satellite was launched according to the program of the IGY. The program of scientific investigations on the satellite was calculated for seven days and was completely carried out. The experiments on this satellite included: 1) investigation of solar radiation in the shortwave ultraviolet and X-ray regions of the spectrum; 2) study of cosmic rays; 3) registration of changes in temperature and pressure and other parameters in the spherical container and in the cabin containing the experimental animals; 4) medico-biological investigations of the vital activity of an experimental animal (the dog Laika) in conditions of space flight; 5) determination of the density of the upper atmosphere (from braking of motion of satellite); 6) ionosphere investigations (from observation of propagation radiowaves radiated from the satellite).

The frequencies of the two radio transmitters were 20.005 and 40.002 Mc. (the wavelengths were about 15 and 7.5 m respectively); the first radio transmitter worked continuously and the radio signals of second were in the form of telegraph messages for about 0.3 sec with a pause of the same duration.

The morning of 14 April 1958 the satellite entered the dense layers of the atmosphere, was destroyed and ceased to exist. From the availabe data the separate parts of the satellite were dispersed along a route, passing above the lesser Antilles, Brazil and the Atlantic Ocean, in a southeastern direction.

[3]This satellite was launched according to the program of the IGY. The following investigations were conducted on the satellite: 1) pressure and composition of atmosphere in the upper layers; 2) concentration of positive ions; 3) magnitude of electrical charge of the satellite and intensity of electrostatic field of Earth; 4) strength of the Earth's magnetic field; 5) intensity of corpuscular solar radiation; 6) composition and variations of primary cosmic radiation, distribution of photons and heavy nuclei in cosmic rays; 7) micrometeorites; 8) temperature inside and on the surface of the satellite.

The frequency of the radio transmitter (Mayak) was 20.005 Mc. for duration of telegraph messages of 50-300 milliseconds with great transmitting power.

On 6 April 1960 the satellite entered the dense layers of the atmosphere and ceased to exist. Based on calculations and in accordance with the data about the last observations the period of the satellite in its last orbit was about 87 minutes.

[4]This satellite was launched in accordance with the plan for creating and developing heavier spaceships. This satellite had a telemetering system to control the parameters of elements of the equipment for trajectory measurements.

The scientific and technical problems set at the launching of the satellite were carried out.

[5]This heavy satellite was launched by an improved multistage rocket into an intermediate earth orbit in order to launch from it a controlled space rocket with a robot space station towards Venus.

A controlled space rocket, which placed a robot space station on a trajectory to the planet Venus, was launched from this satellite.

[6]This heavy satellite was launched by the last stage of an improved carrier rocket into an intermediate earth orbit in order to launch from it a space rocket with the robot space station "Mars-1" towards Mars.

The space rocket, which launched the robot space station "Mars-1" on a trajectory towards Mars, was launched from this satellite.

Table 2. Space Rockets and Robot Space Stations (RSS)

Name and accepted international designation	Date of Launch	Weight of the last stage of the carrier rocket (without taking propellant weight into account)	Total weight of scientific measuring equipment together with power source and container, kg	Weight of RSS, kg	Orbital data				Duration of existence (flight)
					perigee, km	aphelion, km	angle of inclination of orbital plane to plane of the ecliptic	period of orbit around the Sun, days	
First space rocket[1] 1959-μ	2 January 1959	1472	361.3	—	About 146.4 million (Excentricity of orbit, 0.148)	About 197.2 million	About 1°	About 450	Became a satellite of the Sun
Second space rocket[2] 1959-ξ	12 September 1959	1511	390.2	—	—	—	—	—	Reached the surface of Moon in the region of Sea of Serenity, 800 km from the center of visible disk of the Moon
Third space rocket and RSS to the Moon[3] 1959-θ	4 October 1959	1553	156.5	278.5	About 40 thousand (perigee)	About 480 thousand (apogee)	—	About 15 (period of orbit around Earth)	RSS, rounded the Moon and became an artificial earth satellite, completed 11-12 Earth orbits and in April 1960 burned up in dense layers of the Earth's atmosphere
Space rocket and RSS to Venus[4] 1961-γ	12 February 1961	—	—	643.5	106 million	151 million	0.5	—	Became a satellite of the Sun
Space rocket and RSS "Mars-1" to Mars[5] 1962-βν	1 November 1962	—	—	893.5	—	—	—	—	—

Footnotes to Table 2.

[1]The measuring equipment on the rocket was designed to carry out the following scientific investigations: 1) detect the magnetic field of the Moon; 2) study the intensity and variations in intensity of cosmic rays outside the Earth's magnetic field; 3) record photons in cosmic radiation; 4) detect the radioactivity of the Moon; 5) study the distribution of heavy nuclei in cosmic radiation; 6) study the gas component of interplanetary substance; 7) study corpuscular solar radiation; 8) study meteorites. Furthermore, the rocket had special equipment designed to create a sodium cloud, an artificial comet.

To observe the flight of the last stage of the space rocket it was equipped with the following radio transmitters: 1) transmitting on two frequencies: 19.997 and 19.995 Mc, telegraph messages of duration 0.8 and 1.6 sec; 2) transmitting on frequency of 19.993 Mc telegraph messages of variable duration, on the order of 0.5 to 0.9 sec (it transmitted data of scientific observations); 3) transmitting on a frequency of 83.6 Mc and used to measure the parameters of motion of rocket and to transmit scientific information to Earth.

On 4 January 1959 rocket passed the point of its trajectory closest to the Moon; the shortest distance between the rocket and Moon according to specified data was 5-6 thousand km. On approximately 7-8 January the rocket went on an independent orbit, became a satellite of the Sun, the first artificial planet of the solar system.

[2]The measuring equipment on this rocket was designed to carry out the following scientific investigations in outer space during the flight of the rocket to the Moon: 1) magnetic fields of the Earth and Moon; 2) radiation belts around the Earth; 3) intensity and variations of intensity in cosmic radiation; 4) heavy nuclei in cosmic radiation; 5) gas component of interplanetary substance; 6) meteorites. Furthermore, the rocket had special equipment to create an artificial comet, a sodium cloud.

To transmit to Earth all the scientific information, measurements of parameters of motion and to control the flight of the rocket it was equipped with the following radio transmitters: 1) working on two frequencies: 20.003 and 19.997 Mc, transmitting signals in the form of telegraph messages for from 0.8 to 1.5 sec (during pauses in transmission on the first frequency pulses were transmitted on the second frequency); 2) working on frequencies of 19.993 and 39.986 Mc, the signals of which were pulses of variable duration from 0.2 to 0.8 sec with a pulse repetition rate of 1 ± 0.15 Mc; 3) working on a frequency of 183.6 Mc.

The second space rocket was the first to carry out a space flight from Earth to another celestial body, the Moon. In commemoration of this event a message was left on the surface of the Moon with an image of the emblem of Soviet Union and the inscription: "Union of Soviet Socialist Republics. September, 1959."

[3]The outlined program of scientific investigations included obtaining images of the side of the Moon not seen from Earth with subsequent transmission of these images to Earth by equipment on the RSS, and also the carrying out of scientific investigations in interplanetary space.

Transmission of scientific information and the results of measuring the parameters of motion of the RSS was carried out with the help of two radio transmitters, working on frequencies of 39.986 and 183.6 Mc. The signals of the first transmitter were pulses of variable duration from 0.2 to 0.8 sec with a pulse repetition rate of 1 ± 0.15 Mc.

During this flight an RSS launched with the help of a third space rocket on a trajectory circling the Moon first observed that part of the Moon which never had been observed previously from Earth. Photographing of Moon continued about 40 minutes from a distance of 60-70 thousand km; a considerable number of photographs was obtained (in two different scales) of the side of the Moon invisible from Earth. The treatment of photographic films, development and fixing, was automatically conducted on board the RSS. Signals of facsimiles of the Moon were transmitted to Earth with the help of a special radio technical system, which simultaneously ensured the transmission of the data of scientific measurements the determination of orbital elements, and also the transmission from Earth to the RSS of commands controlling its work. Television equipment ensured the transmission of a half-tone image with high resolving power. Transmission of images of the Moon was carried out from the RSS at distance up to 470 thousand km. This was the first experimentally confirmed transmission in outer space at deep-space distances of half-tone images with high clarity without essential specific distortions during propagation of radio waves.

[4]The basic problems of this launch were: a check of the methods of plating an object in outer space on an interplanetary route; a check of super-range radio communications and control of a space station; more precise definition of the scale of the solar system and carrying out of a series of physical measurements to investigate cosmic radiation, magnetic fields, interplanetary substance and record collisions with micrometeorites. The frequency of the radio transmitter on the RSS was 922.8 Mc.

The RSS was launched toward Venus by a controlled space rocket, itself launched from a heavy artificial earth satellite, which was on an intermediate orbit. On 19 and 20 May 1961 the RSS passed at distance of 100 thousand km from the surface of Venus at a total distance of about 270 thousand km. For the first time a new scheme of launching was carried out, the start of a rocket from on board an artificial earth satellite, preliminarily launched on an intermediate orbit. For the first time the route to a planet of the solar system, Venus, was covered.

[5]This space rocket ("Mars-1") was launched toward the planet Mars in accordance with the program of research on space and the planets of the solar system. The basic goals of the RSS "Mars-1" were: 1) to carry out prolonged space research during flight to Mars; 2) to establish interplanetary space radio communications; 3) to photograph Mars with subsequent transmission of the obtained images of the surface of Mars to Earth by radio channels.

Telemetric, measuring and scientific equipment was switched on automatically, in accordance with program of flight and by radio commands from Earth. Tracking the RSS, determining the parameters of its trajectory, and receiving scientific information on Earth were carried out by a special measuring complex and a center of distant space radio communications. The frequencies of the radio transmitters of RSS: 922.76 and 183.6 Mc. The station had three radio-systems, working on waves in the meter (1.6 m), decimeter (32 cm) and centimeter (5 and 8 cm) ranges.

The RSS, "Mars-1," was launched towards Mars by a space rocket, in turn launched from a heavy artificial earth satellite, preliminarily on an intermediate orbit. Preliminary results of treatment of measured information showed that the RSS was on a trajectory close to that calculated. A more precise definition of the trajectory of the RSS showed that its trajectory without considering corrections passed at a distance of 261 thousand km from Mars. The construction of the RSS anticipated correction of its motion during flight by radio commands from Earth with the help of an exact system of astronavigation and a special propulsion system to guarantee of flight of RSS above the surface of Mars at a height from 1 to 11 thousand km.

On 2 November 1962 the astronomical observatories of the Soviet Union photographed the RSS "Mars-1" and the space rocket against the background of the night sky. On the photographs these objects showed up as stars of the 14th and 13th magnitudes respectively.

Radio communications of Mars-1 was supported at distances greater than 100 million km.

Table 3. Spaceship-Satellites

Name and accepted international designation	Launch date	Weight (without the last stage of the carrier rocket), kg	Initial orbital data				Landing data	Duration of flight	Number of orbits around Earth
			perigee, km	apogee, km	angle of inclination of orbital plane to the plane of the Earth's equator	period of orbit around Earth, min			
First spaceship-satellite[1] 1960-ε	15 May 1960	4540 (weight of equipment on board with power source, 1477 kg)	312	369	65°	91.2	Was not planned	63 days	1017
Second spaceship-satellite[2] 1960-λ	19 August 1960	4600	306	339	64°57'	90.7	Landed according to a command from Earth on 20 August 1960	1 day	17
Third spaceship-satellite[3] 1960-ρ	1 December 1960	4563	187.3	265	65°	88.6	Entered the dense layers of the atmosphere and ceased to exist on 2 December 1960	1 day	17
Fourth spaceship-satellite[4] 1960-θ	9 March 1961	4700	183.5	248.8	64°56'	88.6	Landed according to a command from Earth on 9 March 1961	1 hour 46 min	1
Fifth spaceship-satellite[5] 1961-ι	25 March 1961	4695	178.1	247	64°54'	88.42	Landed according to a command from Earth on 25 March 1961	1 hour 45 min	1

Footnotes to Table 3.

[1]This launching was intended to adjust and check the systems of the spaceship-satellite, ensuring its safe flight and flight control, return on Earth and the necessary conditions for a man in space flight. Furthermore, the separation from the spaceship-satellite of a pressurized cabin weighing about 2.5 T was programed (without return on Earth). This launching of the first spaceship-satellite is beginning of complicated work on the creation of reliable spaceships, ensuring safe manned flight in space. The launching showed the correctness of the basic positions in creation of a spaceship. On board the spaceship-satellite there was a pressurized cabin with a load simulating the weight of a man and all equipment necessary for future manned flight in space.

Due to a malfunctioning of the orientation system at the re-entry point there was a rise of the ship, which went onto a new elliptic orbit with perigee of 307 km and apogee of 690 km, period of orbit 94.25 minutes angle of inclination to the plane of the equator 69°.

[2]The basic problem of this launching was further adjustment of the systems ensuring vital activity of a man and also the safety of his flight and return to Earth. During the flight of this spaceship-satellite a series of medico-biological experiments were carried out and the program of scientific space research was fulfilled (investigation of light and heavy nuclei in primary cosmic radiation, investigation of X-ray and ultraviolet solar radiations and recording of doses of space radiation in the container for animals). There were experimental live objects (two dogs, Strelka and Belka, 40 mice, 2 rats, insects, plants, grain of grasses and certain microbes) in the cabin of the ship.

The spaceship-satellite had radio transmitters (Signal), telemetry equipment for transmission to Earth of data about state of experimental animals and the work of the systems on board. There was a radio television system on board to observe the behavior of the animals.

The return of a spaceship-satellite with living beings to Earth was first carried out.

[3]The basic problem of this launching was further adjustment of the construction of the spaceship-satellite and its basic built-in systems necessary for manned flight in outer space: the fulfillment medico-biological investigations in conditions of space flight (experimental life was the dogs Pchelka and Mushka, and insects and plants); a series of scientific investigations in the physics of outer space. Observation of the behavior of the animals was conducted with the help of radio television equipment and telemetry systems.

The ship was launched on a trajectory othere than that planned, in consequence of which during entrance in the dense layers of the atmosphere it ceased to exist.

[4]The basic problem of this launching was further adjustment of the construction of the spaceship-satellite and its basic systems necessary for manned flight in outer space; medico-biological investigations (experimental animals: the dog Chernushka, mice, guinea pigs, frogs, and also insects, plants, grain and other biological specimens). The spaceship-satellite had telemetry and television system, radiotracking system for trajectory measurements and equipment of radio communications. The cabin of the spaceship-satellite contained a mannequin of an astronaut.

[5]The basic problem of this launching was further adjustment of the construction of the spaceship-satellite and its basic systems necessary for manned flight in outer space: medico-biological investigations (experimental life: the dog, Zvezdochka, laboratory mice, guinea pigs, frogs, microbes and viruses, ray fungus, dry seeds of different plants, onion sprouts, and also a solution of deoxyribonucleic acid and different enzymes). The spaceship-satellite contained a mannequin of an astronaut.

Table 4. Vostok Spaceship-Satellites*

Name and accepted international designation of the spaceship-satellite Pilot cosmonaut	Launch date and time (Moscow)	Weight of ship (without the weight of the last stage of the carrier rocket) kg	Initial orbital data				Date and time (Moscow) of landing	Place of landing; coordinates	Duration of flight	Number of orbits accomplished by the spaceship with astronaut during flight around Earth	Flying range, km
			perigee, km	apogee, km	angle of inclination of the orbital plane to the plane of the Earth's equator	period of orbit around Earth, min					
"Vostok-1"[1] 1961-μ, Major Yuriy Alekseyevich Gagarin	12 April 1961 9:07	4725	181	327	64°57'	89.1	12 April 1961, 10:55	In the region north of Smelovka, Ternovsk region, Saratov area, RSFSR, 50°16' north latitude, 45°59' east longitude	1 hr 48 min	1	Over 40 thousand
"Vostok-2"[2] 1961-τ, Major German Stepanovich Titov	6 August 1961, 9:00	4731	183	244	64°56'	88.46	7 August 1961, 10:18	In the region north of Krasnyy Kut, Saratov area, RSFSR, 50° 51' north latitude, 47°1'5 east longitude	25 hr 18 min	17	703,150
"Vostok-3"[3] 1962-αμ, Major Andrian Grigor'yevich Nikolayev	11 August 1962, 11:30	4722 ± ± 5	180.7	234.6	64°58'50"	88.33	15 August 1962,9:52	South of Karaganda, Kazakhstan SSR, pilot astronaut: 48°02' NL, 75°45' EL; Ship Vostok 3: 48°00 NL, 75°45' EL.	94 hr 22 min	64	About 2.64 million
"Vostok-4"[3] 1962-αγ, Lieutenant Colonel Pavel Romanovich Popovich	12 August 1962, 11:02	4728 ± ± 5	179.8	236.7	64°57'10"	88.39	15 August 1962,9:59	South of Karaganda, Kazakhstan SSR, pilot astronaut: 48°10' NL, 71°51' EL; Ship Vostok 4: 48°9' NL, 71°51' EL.	70 hr 57 min		

*Test site: spaceport in the region of Baykonur station, Kazakhstan Soviet Socialist Republic, 47°22' NL, 65°29' EL.

Footnotes to Table 4.

[1]The goal of this flight was to check influence on the human organism of conditions of space flight and successful descent of ship with astronaut to Earth in the assigned region. Citizen of the USSR Yu. A. Gagarin accomplished the first space flight and successful descent to Earth in the assigned region. This flight opened the route for mankind in space. The spaceship-satellite Vostok was launched into an earth orbit by a multistage carrier rocket, having six liquid-propellant rocket engines with a total maximum power of 20 million hp (all stages).

[2]The problems of this flight were: 1) to investigate the influence on the human organism of prolonged (over 1 day) space flight along an orbit around Earth and subsequent descent to Earth; 2) to investigate the efficiency of a man during a prolonged stay in conditions of weightlessness. The flight of G. S. Titov was the first day-long orbital manned flight around Earth. The spaceship-satellite Vostok-2 was launched on an earth orbit by a multistage carrier rocket, having six liquid-propellant rocket engines with a total maximum thrust of 600 thousand kg (all stages).

[3]The goals of launching on low orbits of the two spaceships, "Vostok-3" and "Vostok-4" on low orbits were: 1) to obtain experimental data on the possibility of establishing direct communication between two ships; 2) to coordinate the actions of pilots-astronauts; 3) to check the influence of identical conditions of space flight on different human organisms. Furthermore, it was planned to conduct investigations and experiments in this flight necessary to solve a series of new medico-biological and technical problems.

For the first time a multistage group space flight of two ships simultaneously was accomplished. The distance of group space flight of ships "Vostok-3" and "Vostok-4" on 12-15 August 1962 was 1975 200 km the duration was 70 hours 23 minutes 38 seconds. The minimum distance between ships was about 6.5 km. Spacevision was first carried out in this flight.

Spaceship-satellite "Vostok-3" and "Vostok-4" were launched on earth orbits by multistage carrier rockets, having six liquid-propellant rocket engines with total maximum thrust of 600 thousand kd (the engines of all stages of each rocket).

Table 5. Artificial Earth Satellites of the "Cosmos" Series

Accepted name and international designation	Launch date (1962)	Initial orbital data			
		perigee, km	apogee, km	period of orbit around Earth, min	angle of inclination of orbital plane to the plane of the Earth's equator
"Cosmos-1"[1] 1962-θ	16 March	217	980	96.35	49°
"Cosmos-2"[2] 1962-ι	6 April	213	1560	102.5	49
"Cosmos-3"[3] 1962-ν	24 April	229	720	93.8	48°59'
"Cosmos-4"[4] 1962-ξ	26 April	298	330	90.6	65
"Cosmos-5"[5] 1962-υ	28 May	203	1600	102.75	49 04
"Cosmos-6"[6] 1962-αδ	30 June	274	360	90.6	49
"Cosmos-7"[7] 1962-αι	28 July	210	369	90.1	65°
"Cosmos-8"[8] 1962-αξ	18 August	256	604	92.93	49
"Cosmos-9"[9] 1962-αω	27 September	301	353	90.9	65
"Cosmos-10"[10] 1962-βξ	17 October	210	380	90.2	65
"Cosmos-11"[11] 1962-βθ	20 October	245	921	96.1	49
"Cosmos-12"[12] 1962-βω	22 December	211	405	90.45	65

[1]The satellite was equipped with: scientific equipment for research of the upper atmosphere and outer space, radiotelemetry system and radio transmitter (two-channel radio station), working on two coherent waves, according to specified data, with frequencies of 20.005 and 90.0225 Mc; the second frequency exactly in 4.5 times larger than the first. The duration of a signal bundle was about 4 sec and the pauses were 0.5 sec. The final stage of the carrier rocket also went into orbit, close to the orbit of the satellite.

[2]The satellite was equipped with: scientific equipment; multichannel telemetry system and radiotechnical devices to measure the trajectory; shortwave transmitter "Mayak-2" working on two coherent waves with frequencies of 20.005 and 90.0225 Mc. The duration of signal bundle was 2 sec the pauses were 0.5 sec. According to preliminary data the satellite went into an orbit differing from that calculated. According to trajectory measurements on 7 April 1962, the period of orbit around Earth was 102.25 minutes and the minimum and maximum distance from Earth respectively were 211.6 and 1545.6 km.

[3]The satellite was equipped with: scientific equipment; multichannel telemetry system and radiotechnical devices to measure the trajectory. According to preliminary data, the satellite went into an orbit close to that calculated.

[4]The satellite was equipped with: scientific equipment; radio transmitter "Signal," working on frequency of 19.995 Mc; a radiosystem for exact measurement of orbit and telemetry equipment to transmit to Earth the data about the work of instruments and scientific equipment, fixed on board the satellite. In connection with the completion of program of scientific investigations on 29 April 1962 by command from Earth the successful landing of the satellite was conducted at the assigned place on the territory of the Soviet Union; this satellite was in orbit more than three days, flying about 2 million km during that time. As a result of launching "Cosmos-4" valuable scientific data were obtained.

Continued footnotes to Table 5.

[5]This satellite contained: scientific equipment; multichannel telemetry system and radiotechnical devices to measure the trajectory; shortwave transmitter "Mayak," working on a frequency of 20.008 Mc. According to preliminary data the satellite went into an orbit, differing little from that calculated.

[6]This satellite contained: scientific equipment; multichannel telemetry system and radiotechnical devices to the trajectory; shortwave transmitter "Mayak," working on a frequency of 90.0233 Mc.

[7]This satellite contained: scientific equipment; a radio transmitter working on a frequency of 19.994 Mc; a radiosystem for exact measurement of orbital elements and telemetry equipment to transmit to Earth the data about work of instruments and scientific equipment, on board the satellite.

[8]This satellite contained: scientific equipment; multichannel telemetry system and radiotechnical devices to measure trajectory; transmitter "Mayak," working at frequencies of 20.00504 and 90.02268 Mc.

[9]This satellite contained: scientific equipment; radio transmitter, working on a frequency of 19.994 Mc; radiosystem for exact measurement of orbital elements and telemetry system to transmit to Earth the data about work of instruments and scientific equipment.

[10]This satellite contained: scientific equipment; radio transmitter, working on a frequency of 19.995 Mc; radiosystem for exact measurement of orbital elements and telemetry system to transmit to Earth the data about work of the instruments and scientific equipment.

[11]This satellite contained: scientific equipment; multichannel telemetry system and radiotechnical devices to measure the trajectory; shortwave transmitter working at frequencies of 20.0048 and 90.0216 Mc. According to preliminary data the satellite went into an orbit differing little from that calculated.

[12]This satellite contained: scientific equipment; radio transmitter, working on a frequency of 19.995 Mc, radiosystem for exact measurement of orbital elements and telemetry system to transmit to Earth the data about work of instruments and scientific equipment.