Union Calendar No. 473
86th Congress, 1st Session - - - - - - House Report No. 1086

THE FIRST SOVIET MOON ROCKET

REPORT

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

[No. 33]

AUGUST 31, 1959.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

UNITED STATES
GOVERNMENT PRINTING OFFICE
34006 WASHINGTON : 1959

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., August 20, 1959.

Hon. OVERTON BROOKS,
Chairman, Committee on Science and Astronautics.

DEAR MR. CHAIRMAN: I am forwarding herewith for committee consideration a report, "The First Soviet Moon Rocket," prepared by Special Counsel Spencer M. Beresford, in collaboration with Dr. Charles S. Sheldon II, technical director, and reviewed by other members of the professional staff.

This report is based on testimony obtained in both open and executive hearings before the full committee and before a special subcommittee (chairman, Representative Victor L. Anfuso), and on information obtained through staff research. It summarizes the salient testimony, and presents conclusions as to the lunar probe announced by the Soviet Union on January 2, 1959, and as to the pertinent aspects of Soviet space technology.

CHARLES F. DUCANDER,
Executive Director and Chief Counsel.

I

LETTER OF SUBMITTAL

COMMITTEE ON SCIENCE AND ASTRONAUTICS,
HOUSE OF REPRESENTATIVES,
Washington, D.C., August 31, 1959.

Hon. SAM RAYBURN,
Speaker of the House of Representatives,
Washington, D.C.

DEAR MR. SPEAKER: By direction of the Committee on Science and Astronautics, I submit the enclosed report, "The First Soviet Moon Rocket."

This report has been prepared following investigative hearings by both the full committee and a special subcommittee on the general state of Soviet space technology and also, on the authenticity of the Soviet announced launching of Mechta or Lunik, as it has variously been called.

Although for reasons of security not all the evidence received by the committee could be referred to in the report, enough public information has been given to establish the seriousness of the Soviet challenge and the necessity for the vigorous pursuit of the U.S. program of missile and space development.

The findings and recommendations herein are therefore earnestly offered to the 86th Congress for consideration.

OVERTON BROOKS, *Chairman.*

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AUGUST 31, 1959.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. BROOKS of Louisiana, from the Committee on Science and Astronautics, submitted the following

REPORT

THE FIRST SOVIET MOON ROCKET

I. Introduction

The statement by the Soviet Union in January of this year that it had sent a rocket to the Moon and into orbit around the Sun produced an immediate impact on American space policy. More was involved than just the race to develop rockets and missiles, even with all their implications for national defense. From a broader point of view, this event illustrated the all-encompassing struggle between the Communist and free worlds, including not only their weapons but also rocket blackmail, attempts to sway the uncommitted nations, and other forms of psychological and political warfare. In the background lie even more fundamental questions of general social progress, education, and scientific and technical development.

It is the relation of the Soviet Moon shot to these more fundamental problems, particularly to scientific progress and space technology, that gives this report its significance to the work of the Committee on Science and Astronautics.

Technological progress is much more than a fringe benefit or added fillip to modern life.

Many earnest people, it is true, believe that our material advances are not adding to the real rewards of human life. They worry about increasing dependence upon mechanical contrivances, technological unemployment, and the appearance of an effete population demanding creature comforts and services but without the gumption to meet the challenges life has brought in the past. They also worry about the increasing pace of existence, the exhaustion of readily accessible resources, the pollution of water supplies, and the blight of industrial and motor vehicle smog. With good reason, they worry about the increased dangers of war in a time of superweapons.

Perhaps some of these complaints and worries are legitimate, and the costs of some technological changes are greater than the real gains. But however fondly the individual may look back upon some earlier period, slower paced and with nature unspoiled, such views do not reach the essentials of the problems faced by modern societies. Population is expanding in many parts of the world, creating pressure on facilities and even food supplies. Accessible resources are becoming harder to find. Many discoveries which are generally accepted as worthwhile have placed demands on us for new ways to produce, and for cost savings to attain the balance of resource allocation required to meet competing ends. The world has not yet solved the problems of national rivalries, which are in part a reflection of conflicting ideologies as well as the natural self-interest of sovereign states. We are especially conscious that changes in technology have increasingly compressed the time for travel from one point to another, and that communications are virtually instantaneous.

The combined effect of these developments makes it harder for individual nations to go their separate ways without worry of what others may do. One might say the world is almost becoming too small to hold the divergent interests and views of the many groups organized on this planet, even as we recognize fresh opportunities for science and technology to feed all people better than before and solve many other problems. This fact may give a special significance to the beginnings of space travel.

It is also apparent that modern science and technology have become so widespread over the face of the globe that, although many countries cannot marshal the resources to do any task they might wish to accomplish, nonetheless they can do more than ever before, and even some small nations have the potential to affect the course of human events on a very considerable scale.

It is within the framework of these discoveries, inventions, and developments, coupled with capital accumulation, population growth, and differing but dynamic ideological views, that military realities must be judged. Along with the general developments have come new weapons of tremendous power, capable of very destructive employment even over great distances.

As a result of these many interrelated conditions, we cannot afford to abandon technology. We may stress new cultural interests, zone and legislate against the blight of industry and urban sprawl, and seek values which encourage individual worth. But whatever we do, unless we are foremost in technology, neither will our peaceful economic development continue to meet the rising problems of scarcity, nor will we survive against military force or even cold-war pressure from outside.

The Committee on Science and Astronautics devotes its attention to the grave problems of public policy surrounding the support and use of technology and science. Few other problems offer the same opportunities for anticipating national needs and planning in a rational way to meet them.

At one time it was the popular view, while recognizing the importance of science abstractly, that in American circumstances scientific progress could take care of itself. Individual inventors were free to experiment and to contrive what they could. We were known as a nation of tinkerers with great ingenuity, and as a practical people able to apply knowledge to consumer goods or production in general. Much of our basic knowledge came from Europe, where the traditions of the universities encouraged a somewhat different outlook and balance of work. The flow of information was relatively free in all parts of the world.

This situation has now changed fundamentally. Practical applications of scientific discoveries have almost outrun the supply of fundamental knowledge. Development work in particular has required larger and larger investments of time, manpower, and money as our goals have become more ambitious. In some fields, individual effort has become team effort and has been institutionalized. With the growth of human knowledge, the time for training people has had to be extended, and perhaps the training has become more rigorous. Indeed, more specialization has been required, and, in the process, communications problems among specialists have become more acute. A large part of research has come under military sponsorship even in

the free world, not to mention the problems of covering the work conducted in totalitarian states with their elaborate security systems. No longer can the United States assume that a mere appreciation of science and technology is enough. We must think more specifically in terms of what policies and incentives will insure that our progress is as rapid as our well-being—and indeed our survival—require.

The shock to the public and to our officials accompanying the launching of the Soviet sputniks came almost too late. It is little consolation that some individuals could take pride in reminding us that their warning voices had long been raised even though unheeded. Following the initial stunned reactions to these Soviet successes, the Congress moved to study and provide for immediate needs. The first result was the creation of the National Aeronautics and Space Administration. Others were the immediate provision of more support for our missile programs and the work of the Advanced Research Projects Agency. Now, with the passage of time, it is desirable to look over a wider range of problems, to spot some of the trends and to propose corrective measures where the trends may lead to pernicious results.

In this calmer atmosphere, the Committee on Science and Astronautics has begun comparative studies of technology and science and of what these suggest to policymakers as courses of action. Soviet space technology was taken as a starting point because it seems a useful bridge between the very immediate and very real problems of rivalry, which needed early attention, and the more fundamental problems which are sure to continue for the indefinite future.

Soviet technical accomplishments, particularly in astronautics and in nuclear weapons, pose an early threat to our survival. Our response may be to speed the development of corresponding weapons, to shore up our defenses, to strengthen our alliances. But the short-run response to these particular threats will not be adequate to meet the full challenge because these problems are too complicated for any easy solution. In astronautics and missilery, it may prove very difficult to buy lost time at any price. It may take years of single-minded effort to build an adequate foundation for our national life, including our educational system and our national attitudes toward intellectual achievement.

If we did not have faith that the American public will rise to these multiple challenges, when Congress, the President, and other leaders have shown the way, there would be little point to the work and purposes of this committee.

The problems confronting the Nation are not just a bad dream that will go away when we wake up. They are terribly real. Our place in history and the life we want our people to lead—in peace, moderate comfort, and greater human understanding—may all be swept away unless we recognize the problems we face and meet them with resolution

II. Soviet Technological Accomplishments

The Soviet Union has presented to the world a record of accomplishment across a broad front, arranging the facts or the appearances to maximize their impact on both their own people and upon the uncommitted or free world nations. The Soviet leaders recognize the value

of extracting maximum political and psychological effect in pursuing their cold war goals. That there is another side to the story, one of shortages and failures elsewhere in their society, is something they either gloss over or deny.

The Soviet economy is growing at a rate higher than that of the more advanced countries. This growth has real dangers if its products are to be used for armaments or supporting aggression. The other part of the story, which seems contradictory but really is not, is that the Soviet economy began its growth at so low a level that even today it continues to lag far behind the United States in material living standards and even in heavy industrial strength. The real threat is what the Soviet leaders can choose to do with the increments of production which are coming to them each year.

Soviet education represents a second field where impressive results have been obtained. Such an effort is being made, particularly in science and engineering, that another 10 years of the same trends in both countries will give the Soviet Union a distinct advantage over the United States in numbers of technically trained people. The other side of the story might show some overspecialization, too little independent thinking, and neglect of the social sciences and humanities. Whatever other drawbacks can be discovered, however, this program of education can support both Soviet military power and programs of technical aid in the uncommitted countries.

Soviet public works programs have been given extensive propaganda coverage. These include some of the world's largest hydroelectric dams, on the Volga and on the Siberian rivers, plans for large capacity canals and inland seas, new atomic power stations, tremendous numbers of new apartment buildings. These programs are impressive, but the official photographs fail to show that the new apartment buildings develop cracks and the plaster peels off. Soviet propaganda fails to emphasize that major programs are postponed indefinitely, such as the Turkmen Canal, the new Siberian Sea, and the railway to the Bering Straits. Still, the point is that even what is done and does work is enough to represent a major expansion of Soviet capabilities, even though lagging behind the United States.

Soviet science has many successes to show the rest of the world. Soviet scientists have a very large number of institutes and a large output of scientific journals and literature. They are doing good work in high energy physics, including the operation of the 10-billion-volt accelerator at Dubna. They do good work in radar and electronics and optics. Their research in materials is impressive. And yet here, too, many Soviet facilities seem crude and backward by our standards. But the Soviet Government uses all the resources of a police state to comb the whole world for information, and then makes it available in translation promptly to its technical people. The combined effect of all these efforts on net balance represents a formidable accomplishment.

This report has been deliberately kept within manageable limits by concerning itself primarily with Soviet space technology. It is evident that the most careful attention has been paid by the Soviet leaders to political and psychological effects. Nevertheless, Soviet propaganda claims in the field of astronautics are apparently based on solid achievements; otherwise they would run the risk of serious whiplash effects if disproved.

After World War II, the Soviet Government decided very promptly to pursue ballistic rocketry to continue the Russian tradition of rocket development. Captured German personnel and facilities were strenuously exploited. But the Soviet Union simultaneously pursued an independent effort of its own. In the early 1950's, Soviet propaganda organs began to whet public appetite for the coming great advances in lunar and planetary exploration. The actual work continued pretty much in secret, with strong emphasis on one family of relatively short-range ballistic weapons which could be employed against neighboring states if the occasion arose. The Soviet Union also developed an intercontinental missile of very large thrust, designed to carry, if need be, a very heavy warhead.

During the same period, the best technical advice in the United States was that very big warheads would prove too expensive to deliver by missile; and our own work consequently ran at a low level of support until the new, small warheads were developed. As a result, our military boosters afford only a moderate capability to put weight into orbit, while the Soviet capability derived from military missiles is somewhat greater.

In the middle 1950's, the Soviet Union began to release occasional spot stories, usually incomplete and sometimes garbled, about dog or monkey shots and other sounding rocket efforts. Whatever difficulties were encountered in rocket development—and some could scarcely have been avoided—were carefully hidden from world view by travel restrictions which preserved the privacy of Soviet launching sites.

Once the Soviet Union was sure of its technological proficiency, particularly by 1956 or 1957, it began to issue prophetic statements which it was then able to carry out with appropriate public claims after the fact. These have been carefully staged, perhaps representing the best use of technical talent, but also done in such a way as to keep the world guessing and off balance—larger weights sent up each time, and no failures.

Let us review in brief the claimed Soviet accomplishments:

Orbiting vehicles

Oct. 4, 1957	Sputnik I—184 pounds of instruments, orbit between 142 and 588 miles above Earth.
Nov. 3, 1957	Sputnik II—1,120 pounds of instruments, orbit between 140 and 1,038 miles above Earth.
May 15, 1958	Sputnik III—2,134 pounds of instruments in a 2,925-pound capsule, orbit between 135 and 1,167 miles above Earth.
Jan. 2, 1959	Lunik or Mechta—796 pounds of instruments in a 3,245-pound capsule, orbit around the Sun after passing within 3,700 miles of the Moon.

Sounding vehicles

Feb. 21, 1958	Geophysical laboratory with 3,000 pounds of instruments sent 294 miles up.
Aug. 27, 1958	Dogs and instruments weighing 3,718 pounds sent 281 miles up.
July 2, 1959	Dogs and instruments weighing 4,400 pounds sent about 300 miles up.
July 10, 1959	Dogs and instruments weighing 4,840 pounds sent about 300 miles up.

These accomplishments are technically to be expected of a nation which started serious work on ballistic rockets at an early date and built large boosters. The weights involved are much greater than most of the American launchings but are not greater than we hope to accomplish later even with our smaller ICBM's when improved upper stages are available.

But even if we take the Soviet launchings at face value, accepting the weights which have been reported, there are many related questions which remain unanswered, and the data supplied by Soviet propaganda have to be checked for any independent verification.

III. The Soviet Moon Rocket

INTRODUCTION

On January 2, 1959, Soviet space technology again became a subject of lively public debate.

Ironically, the House Select Committee on Astronautics and Space Exploration adopted a resolution on that very day (the last day of its existence), urging all possible speed in the launching of another U.S. space probe. At the time the committee met, the Soviet Union had just launched, or so it later announced, a 3,245-pound rocket with a payload of 796 pounds on its way toward the Moon. Still later, Soviet sources said that the rocket had missed the Moon by 4,700 miles or so (they quickly lowered the estimate to 3,700 miles), and gone into orbit around the Sun.

From a propaganda standpoint, the Soviet announcements were well timed. Earlier attempts by the United States to send a rocket to the Moon had come close to success, but failed. The Soviet rocket was launched at almost the same time as the departure of First Deputy Premier Anastas Mikoyan for a visit to the United States, and the opening of the Twenty-first Congress of the Soviet Communist Party. This new Soviet success in astronautics also diverted attention from the American "talking satellite" (Project Score) from which the President's Christmas message had recently been relayed to the nations of the world.

On the following day, the President made a statement congratulating the scientists and engineers responsible for the launching of the Soviet rocket. Further announcements concerning this event were given extensive coverage by the Western press. As time passed, however, it became evident that the event was reported almost exclusively by Soviet and other Communist sources, without much independent verification. Little by little, the front-page repetitions of Soviet claims begun to be matched by smaller but persistent stories that the Soviet announcements were false and that the world had swallowed a gigantic hoax.

One of the would-be debunkers was Lloyd Mallan, a science writer, whose article, "The Big Red Lie," published in True magazine on April 11, 1959, attracted national attention.

The Committee on Science and Astronautics has felt a public responsibility to investigate the evidence for and against the authenticity of the Soviet launching and its probable results. The same evidence could throw important light on the Soviet timetable and level of accomplishment in space technology. Hence, the various published

stories which were skeptical of the Soviet announcements, including the article by Lloyd Mallan, merely triggered certain studies which the committee had already decided to undertake, of which the question of the Soviet Moon rocket was only a part. The committee is interested in the general level of Soviet scientific and technical accomplishment, and in later studies and reports will explore this subject more thoroughly.

Soviet announcements of astronautical achievements are obviously self-serving. Historically, the Soviet Union has exaggerated its economic growth by selection, suppression, and distortion of data; it may apply the same techniques to its scientific and technical progress. Soviet astronautical accomplishments are real and impressive. If we overestimate them, however, our response may be premature, excessive, unbalanced, or wasteful. We may be inhibited from making a determined stand against Soviet cold-war moves, and our gullibility may make us vulnerable to deception. For similar reasons it would be equally damaging for us to disbelieve or belittle Soviet claims without careful investigation. The only safe course of action, therefore, is to keep up our mental as well as our material defenses, to receive Soviet statements with an open mind but with caution, and to suspend our judgment as to Soviet scientific and technical achievements until they have been verified by independent free-world sources.

THE SOVIET ANNOUNCEMENTS

During the evening of January 2, 1959, the Moscow Radio "Soviet Home Service" announced that on that day "a cosmic rocket was launched toward the Moon in the U.S.S.R." According to this broadcast and later Soviet announcements (collected in the appendix of this report), the multistage rocket veered eastward after a vertical launch. The nose cone of the final stage was then ejected, and the final stage reached a speed of more than 7 miles a second (the so-called second cosmic speed or escape velocity). The final stage contained instruments for measuring the Moon's magnetic field and radioactivity, cosmic rays, protons, and heavy nuclei in cosmic radiation, interplanetary gases, corpuscular solar radiation and meteoric particles. It also contained radio transmitters broadcasting on three frequencies (19.993, 19.995, and 19.997 megacycles) of approximately 20 megacycles and a fourth frequency of 183.6 megacycles. Two pounds of sodium released at a distance of approximately 70,000 miles from the Earth formed an "artifical comet," visible from the Earth as a sixth magnitude star in the constellation of Virgo.

The final stage carried pennants with the coat of arms of the Soviet Union and the inscription "Union of Soviet Socialist Republics. January—1959—January." In addition, it contained a steel sphere with similar inscriptions.

It is interesting that no facsimile scanner for "taking the Moon's picture" at close range was included in the payload.

According to Soviet sources, the radio transmitters and scientific instruments worked normally and reliably. Radio signals from the rocket were received in the U.S.S.R. and other countries of the Soviet bloc. The time taken to reach the vicinity of the Moon was about 35 hours. After passing the Moon at a distance of about 3,700 miles,

the rocket continued its flight as a new member of the solar system in orbit around the Sun.

At first the Soviet Moon rocket was popularly called Lunik (i.e., Moon satellite). Its name was later changed to Mechta (dream).

HEARINGS

Ten hearings, both public and executive, were held on the Soviet Moon rocket and related Soviet technology by the full committee and a special subcommittee. While much of the evidence on both subjects is classified, the rest of this report summarizes the salient testimony as far as possible, and presents the findings which flow from the evidence as a whole.

Hearings were held on May 11, 12, 13, 14, 28, and 29, 1959. The following witnesses were heard:

Benham, Dr. Thomas A., professor of physics, Haverford College.
Curtis, Dr. Harold O., Chief of Operations Branch, Project Space Track, U.S. Air Force Cambridge Research Center, Bedford, Mass.
Daigh, Ralph, vice president and editorial director, Fawcett Publications.
Dryden, Dr. Hugh L., Deputy Administrator, National Aeronautics and Space Administration.
Fox, Lt. Col. James H., USAF, member of Air Technical Intelligence, Wright-Patterson Air Force Base.
Godel, William H., Director, Policy and Planning Division, Advanced Research Projects Agency.
Hall, Col. Linscott A., USAF, Deputy Director of Estimates, Office, Assistant Chief of Staff, Intelligence.
Mallan, Lloyd, science writer.
Morris, Capt. Jack, USAF, Office of Air Force Intelligence.
Pickering, Dr. W. H., director, Jet Propulsion Laboratory, Pasadena, Calif.
Shapley, Dr. Alan H., Assistant Chief of the Radio Propagation Physics Division of the National Bureau of Standards, Boulder Laboratories, Boulder, Colo.
Singer, Dr. S. Fred, associate professor of physics, University of Maryland.
Slavin, R. M., Director, Project Space Track, Air Force Cambridge Research Center, Bedford, Mass.
Stewart, Dr. Homer J., Director of Planning and Evaluation, National Aeronautics and Space Administration.
Ziegler, Dr. Hans K., Assistant Director of Research, U.S. Army Signal Research and Development Laboratory, Fort Monmouth, N.J.

The first witness was Lloyd Mallan, the author of "The Big Red Lie." In essence, his argument was, first, that virtually all our information about the Soviet Moon rocket came from Soviet sources and that free-world confirmation was scanty, at best, and secondly that the Soviet Union lacked the scientific and engineering competence required for such an achievement.

Mallan concluded that the Soviet Moon shot announcement of January 2, 1959, was a hoax, after making a 2-month, 14,000-mile trip through the Soviet Union. In the course of his visit, he talked

with many scientists and engineers and saw various tracking stations and other scientific centers. He told the committee that he knew no Russian, and relied on a girl interpreter (provided by the Soviet Government) who knew no science.

On the presumption that Mallan's views and statements were prompted by public spirit, and in any event constituted part of the pertinent evidence, the committee and its subcommittee heard him at some length. If he was misled, sufficient explanations could be found in his lack of scientific training and experience, selective control by Soviet authorities of what he was shown or told or allowed to see or hear in the Soviet Union, and the fact that he had no access to classified U.S. information. Under questioning, however, he admitted that he was recruited in 1937 by the North American Committee for Technical Aid to Spanish Democracy, and served during 1937 and 1938 in a Spanish Loyalist unit which was absorbed into the Abraham Lincoln Brigade. He added that he did not know until May 27, 1959, that he had served in the Abraham Lincoln Brigade or that the brigade was included in the Attorney General's list of subversive organizations.

As to independent evidence of the Soviet Moon rocket, Mallan stated that if such a shot had been made the radio signals transmitted by the rocket would probably have been detected by the tracking equipment at Jodrell Bank (in England), Goldstone (operated by the Jet Propulsion Laboratory of the California Institute of Technology), and Menlo Park (operated by the Stanford Research Institute), and by various U.S. military installations. As to Soviet space technology, Mallan described the guidance systems, tracking cameras, and the like which he saw in the Soviet Union as "primitive" and "old hat."

Although Mallan was aware that signals believed to be from Lunik had been received by the Goldstone Station, he characterized these as "radio emissions from the planet Jupiter."

The radio signals received by U.S. stations on January 3 and 4 on the frequencies announced by the Soviet Union constitute a major body of evidence bearing on the authenticity of Lunik. According to R. M. Slavin, the director of Project Space Track, U.S. Air Force, messages were sent on January 2 to all cooperating stations, listing the announced frequencies and requesting that they be monitored. As a result, many reports were received. Only two, however, contained tracking data; these were the reports from the Jet Propulsion Laboratory (Goldstone) and from the Stanford Research Institute.

Dr. Pickering, the Director of the Jet Propulsion Laboratory, testified that the Goldstone Station received no signals on January 3. At about 3 a.m. on January 4, however, the station detected signals on 183.6 megacycles, and tracked an object to the west of (and moving away from) the Moon. Dr. Pickering said there was no doubt in his mind that the object being tracked was the Soviet Moon rocket.

When asked if the signals could have come from Jupiter, Dr. Pickering replied that Jupiter was not in the right position at the time but was located some 15° away from the apparent signal source, and, furthermore, that Jupiter emits an altogether different type of signal—not modulated and periodically fluctuating but a mere random "noise" like static or the radio emissions from thunderstorms.

On the other hand, it is noted that the Goldstone Station failed to detect any signals on January 3. It tracked for only 3 hours. The

signals were so weak and unsteady that automatic tracking equipment was unable to "lock on." (By some definitions, therefore, the station was not "tracking" at all.) Furthermore, the signals received at Goldstone appeared to come from a point about 6° west of the moon and at about the Moon's distance. The margin of error implied by this description is 10,000 miles or more.

During the same night, the large radiotelescope at Jodrell Bank in England also searched in the vicinity of the Moon over a frequency band covering 183.6 megacycles but failed to receive any signals. Dr. Lovell, the director of Jodrell Bank, sent the following telegram to the committee:

> We did not succeed in detecting any signals from Lunik. Search was made with the large radiotelescope over a frequency band covering 183.6 megacycles, which was the stated tracking frequency during the night of January 3–4 when Lunik was said to be close to Moon. No tracking errors could account for failure because telescope beam was adequate to cover position of probe at time of close approach. Telescope was in similar operational condition which has enabled us to track Pioneer to 400,000 miles east. We conclude that Lunik was not transmitting continuously at least on this frequency during that night. Emphasize that this does not imply that we do not believe in existence of Lunik. That frequency might have been inoperative or some special ground command or other features which are current in American probes, for example, might make reception impossible without special apparatus. We were not forewarned in spite of previous close association with Russian scientists responsible. Neither have we received any satisfactory explanation from our inquiries by letter to Russia or from the Soviet delegate at the Hague meeting of COSPAR.

Various explanations have been offered for the failure of Jodrell Bank to detect any signals. Dr. Pickering emphasized that it is very difficult to detect and track a given frequency on short notice. He also suggested the possibility that the signals were turned off except when the Moon rocket was visible from the Soviet Union. Mr. Slavin, the director of Project Space Track, tended to support the first explanation, saying:

> We have, I believe, as fine equipment as exists for our own lunar shots. [But] when suddenly we are faced with a shot on an unannounced frequency, we are caught rather flat-footed.

The Stanford Research Institute was also notified on January 2 that a Soviet Moon probe had been launched. On January 3 it began monitoring 19.993, 19.995, and 19.997 megacycles. Signals were first received at about 1045 (universal time), and were recorded on magnetic tape for about 45 minutes. They were weak and fading, with some Doppler shift (though less than expected), and seemed to follow the Moon by about an hour and a half.

Signals on the same frequencies were also received by the Army Signal Corps Station at Fort Monmouth, N.J. Dr. Ziegler, the

director of astroelectronics at Fort Monmouth, testified that these signals were—

> * * * certainly in the area of frequencies which have been quoted in which the Russians would transmit, and they have appeared in the time frame which would be expected, and they have had no characteristic which would contradict that they could have originated from a space program.

The fact that the Soviet Union released trajectory information while Lunik was still transmitting on announced frequencies indicates confidence that tracking by Western countries would not reveal any contradictory information.

Another body of evidence bearing on the authenticity of Lunik is the publication in the Soviet Union of information supposedly obtained by Lunik during its flight to the Moon. This information was first published in Pravda on March 6, and then in greater detail on April 11 in the Reports of the Soviet Academy of Sciences under the title "A Study of Terrestrial Corpuscular Radiation and Cosmic Rays During the Flight of the Cosmic Rocket." In the magazine article, the trajectory of Lunik is plotted out to a distance about one-third as far as the Moon. According to Dr. Pickering, the information contained in these articles is "quite similar to what we received on Pioneers III and IV."

Dr. Dryden, the Deputy Administrator of the National Aeronautics and Space Administration, stated that the magazine article—

> * * * is in quite a lot of detail, and agrees in its general features with the results that we have obtained with our instruments * * *. As far as we can tell * * * they have rushed into print to get their data before us to prove that they know about the Van Allen radiation belt. * * * Their satellites did not reach high enough to get the information. They did get it with Mechta.

Most of the witnesses stated, with varying degrees of assurance and cogency, that they believed the Soviet Union had indeed, as it announced, sent a rocket to the vicinity of the Moon. Several of them added that they knew of no reputable scientist who would disagree. Some doubts, however, were expressed as to how far the rocket went or how close it came to the Moon. For example, Dr. Thomas Benham, professor of physics at Haverford College, said merely:

> I have no opinion as to whether the Russian Lunik was a success [i.e., reached the vicinity of the Moon] or not.

Prof. Fred Singer of the University of Maryland expressed his views as follows:

> There is very adequate evidence that Lunik was launched and that some of its instrumentation worked. * * * We can be sure that the rocket went out, I would say, about half the distance to the Moon at least, but that is all we can be sure of.

The director of Project Space Track, R. M. Slavin, stated positively:

> From their [Soviet] position announcements, our conclusion is that these [free world] observations definitely confirm the Russian announcement that they had a vehicle reach the vicinity of the Moon.

In general, the Government witnesses appeared to feel greater certainty than private scientists and lay observers.

There is some evidence that Lunik was intended to hit the Moon, and not merely to pass it at close range. According to Soviet sources, the payload included equipment for measuring the Moon's radioactivity and magnetic field; these experiments could not be carried out at any great distance from the Moon, but for all practical purposes presuppose a lunar impact. The payload also included a metal tape and sphere with Soviet inscriptions, apparently intended to support a territorial claim by symbolic "occupation" of the Moon.

As far as the committee could determine, no photographic evidence of Lunik is available in the free world. A supposed Scottish photograph was found to have been taken at a time when Lunik would not have been visible from Scotland. A report that the Palomar Observatory in California had obtained photographic evidence was denied by Dr. I. S. Bowen, the director, who stated that what was at first thought to be Lunik was identified on closer examination as a photographic defect. Other reports of Lunik photographs also proved to be unfounded.

Considerable testimony was elicited on Soviet space technology in general. Dr. Homer Newell, of NASA, describing equipment he saw in Soviet research installations during a 2-week visit to Moscow, said that:

> In the field of upper air sounding and instrumentation, I was satisfied that their equipment was very good. There were some pieces of equipment that did not seem to be as good as ours, but there were others that looked just as good, maybe even better.

He said that he saw some equipment said to have been used in Sputnik III (including transistors)—

> * * * laid out in open form on a bench nearby so we could look at the individual instruments. One could tell from the way in which the wiring was done, the mechanical construction was worked out, and so on, that it was very well done.

He concluded that in upper atmosphere research, at least—

> The Soviets are dealing with the same types of problems we are; they are solving them as well as we are; and, in addition, they are making a greater effort.

Col. Linscott A. Hall, of Air Force Intelligence, stated:

> * * * our information tends to support the belief that they are quite good in their guidance systems, in their propulsion systems * * *.

The Soviet Union, he said, is considerably ahead of the United States in missile experience, having begun its guided missile program in 1947. Hence, the United States probably still has a way to go, in order to—

> * * * catch up with the Soviets in terms of guidance and propulsion, which are the two major factors in the missile field.

The Chairman inquired:

> Do you think we are behind the Soviets in guidance?

And Colonel Hall replied:

> I would say that is probably true; yes, sir.

Dr. Dryden pointed out that the perigee altitudes of the first three sputniks were 142, 140, and 135 miles, according to computations made in this country. For comparison, the perigees of the Explorer satellites launched by the United States were stated as follows: Explorer I, 224 miles; Explorer III, 121 miles; Explorer IV, 163 miles. Dr. Dryden made this comparison as—

> * * * evidence that the guidance equipment in the sputniks is more accurate than that in Explorer.

He pointed out, however, that we did not use our ballistic missile guidance system in the Explorers because it weighed too much.

Dr. Pickering referred to the nearly identical inclinations of the three sputniks to the Equator: 65°, 65°, and 65.3°.

These comparisons evidently assume that each country was trying to launch its satellites to the same perigee altitude and inclination to the Equator.

Professor Singer commented that it is not possible to judge the accuracy of Soviet guidance since the Soviet Union did not announce the orbits of its satellites or the trajectory of its Moon rocket in advance. Assuming that Lunik was intended to hit the Moon, he said, its guidance must have been pretty good, though only marginal for an ICBM. The perigees of the sputniks indicate that the Soviet Union can control an orbit to within about half a degree—good for a satellite, but not for an ICBM.

As to the miniaturization of electronic components by the Soviet Union, the evidence was somewhat conflicting. All the witnesses agreed, however, that miniaturization is unnecessary if very powerful rockets are used. According to Professor Benham, whether Soviet electronic components are miniaturized or not has nothing to do with the success of Soviet rocket shots.

Colonel Hall remarked:

> * * * I think we are probably considerably ahead of the Soviets in miniaturization, but do they need it when they put up sputniks in terms of 3,000-pound weights * * *?

Mr. Slavin expressed the same thought more tersely:

> * * * if you have the brute force, you don't need the miniaturization.

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IV. Summary

RECEPTION OF SIGNALS ON ANNOUNCED LUNIK FREQUENCIES

The Soviet Union announced that Lunik would transmit on four frequencies. A number of stations in the United States and some in other Western countries received signals on one or more of the announced frequencies at the indicated time. It is true that very little tracking information was obtained; in fact, the only tracking information that has been publicly released (obtained by the Goldstone Station) is very rough and scanty. Nevertheless, it would have been extremely difficult for the Soviet Union to simulate the signals that were received. Qualified witnesses testified that such simulation would have been a technical achievement at least as great as sending a rocket to the Moon. The possibility that radio signals from Jupiter, television broadcasts, or the like were mistaken for Lunik signals has been eliminated beyond a reasonable doubt.

SOVIET SPACE TECHNOLOGY

After the sputniks, there is no serious question that the Soviet Union could have developed sufficiently powerful propulsion systems to send a rocket to the Moon.

Without knowing the intended trajectory, it is not possible to judge the accuracy of the guidance system used in the Soviet Moon rocket. Assuming that the rocket was intended to hit the Moon, a miss of several thousand miles would indicate a high degree of accuracy, though not high enough for an ICBM. On the other hand, no one in the non-Communist world can verify that the Soviet Moon rocket came within 10,000 miles or more of the Moon. The closeness of the sputnik perigees suggests that the Soviet Union has very good guidance systems. Again, however, without knowing what orbits were intended, it is not possible to judge the accuracy of the guidance employed.

In other aspects of science and technology required for a Moon shot, such as circuitry and astronomy, the Soviet Union appears to be sufficiently competent. Miniaturization of electronic components would not be necessary in view of the large vehicles and powerful rockets used by the Soviet Union.

V. Conclusions

THE SOVIET MOON ROCKET

1. Although absolutely convincing proof is not available, there is a preponderence of good evidence that the Soviet Union, in the first few days of 1959, launched a rocket toward the Moon. (This conclusion is consistent with the fact that free-world reception of radio signals on the announced frequencies was spotty and unsatisfactory. Only specially designed and carefully adapted equipment could be expected to receive the signals. We have sometimes experienced difficulties in receiving signals from our own satellites.)

2. There is enough good evidence to raise a presumption that the Soviet rocket reached the vicinity of the Moon. (The scattered free-

world tracking data are consistent with Soviet claims that the vehicle, like our own Pioneer IV, reached escape velocity.)

3. On the other hand, there is no independent evidence of the exact details of the Soviet Moon shot, such as the time and place of launching, the weight of the vehicle, and the closest approach to the Moon.

4. The Soviet rocket was probably intended to hit the Moon, not merely to come close.

5. There is a reasonable presumption, though no independent evidence, that the Soviet rocket, after passing the Moon, continued in orbit around the Sun. (Since the Earth and the Moon are both themselves in orbit around the Sun, this outcome would not be difficult to achieve—in fact, it would be difficult to avoid.)

SOVIET SPACE TECHNOLOGY

1. The sending of a rocket to the Moon in early 1959 was within the apparent scientific and engineering capabilities of the Soviet Union. (By starting early, making a consistent large-scale effort, and vigorously exploiting all sources of knowledge both at home and abroad, the Soviet Union seems to have gained a distinct advantage over the United States in space technology. It has made a strong effort in all the many pertinent fields of science and engineering.)

2. In propulsion, the announced Moon rocket would represent no more than a normal progression from the sputniks. (Because of its early attempts to boost heavy warheads by rocket, the Soviet Union has developed a very large reliable booster. The power of Soviet rockets has been independently confirmed from the weights of the sputniks, which can be estimated from their brightness and shape and the length of time they remain in orbit.)

3. There is considerable evidence that Soviet guidance systems are accurate enough for a lunar probe, though it is not possible to be sure without knowing either the intended orbits of the sputniks or the intended trajectory of the Soviet Moon rocket.

4. There is very little unclassified evidence concerning other aspects of Soviet space technology, such as reentry and tracking capabilities. As far as it is possible to determine, Soviet scientific and engineering capabilities are adequate in all respects for a lunar probe.

APPENDIX

Official Sino-Soviet Bloc Announcements on Mechta

Moscow Radio, "Soviet Home Service," January 2, 1959, 2142 G.m.t.

* * * On January 2, 1959, a cosmic rocket was launched toward the Moon in the U.S.S.R.

The multistage cosmic rocket has developed according to program, following the correct trajectory, in the direction of the Moon. According to preliminary data, the last stage of the rocket received the requisite second cosmic speed. Continuing its progress the rocket has crossed the eastern border of the Soviet Union, passed over the Hawaiian Islands, and is continuing to move over the Pacific Ocean, rapidly moving away from the Earth.

At 0310 Moscow time, on January 3, the cosmic rocket, moving toward the Moon, will pass over the southern part of Sumatra, at a distance of about 110,000 kilometers from the Earth. According to preliminary calculations, which are being made more precise by direct observation, at approximately 0700 on January 4, 1959, the cosmic rocket will reach the area of the Moon.

The last stage of the cosmic rocket, weighing 1,472 kilograms, without fuel, is equipped with a special container in which are placed the measuring instruments for the carrying out of the following scientific observations: Ascertaining the magnetic field of the Moon; the study of the intensity and the variations of intensity of cosmic rays outside the magnetic field of the Earth; the registration of protons in cosmic radiation; the discovery of the radioactivity of the Moon; the study of the distribution of heavy nuclei in cosmic radiation; the study of the gas components of interplanetary matter; the study of corpuscular solar radiation; and the study of meteoric particles.

For observation of the flight of the last stage of the cosmic rocket there have been installed in it a radio transmitter emitting on two frequencies—19.997 and 19.995 megahertz—telegraphic messages of a duration of 0.8 to 1.6 seconds, and a radio transmitter working on a frequency of 19.993 megahertz emitting telegraphic messages of a variation duration of 0.5 to 0.9 seconds, by means of which the data of scientific observations are being emitted, and a radio transmitter working on a frequency of 183.6 megahertz, which is being used for measuring the coordinates of the movement and the transmission to Earth of scientific information, as well as a special instrument designed to create a sodium cloud of an artificial comet.

The artificial comet may be observed and photographed by optical means equipped with light filters eliminating the spectral line of sodium. The artificial comet will be formed on January 3 at about 0357 hours Moscow time and will be visible for about 2 to 5 minutes

in the constellation of Virgo, approximately in the center of a triangle formed by the stars Alpha Bootes, Alpha Virgo, and Alpha Libra.

The cosmic rocket is carrying pennants with the coat of arms of the Soviet Union and the inscription "Union of Soviet Socialist Republics, January 1959."

The total weight of scientific and measuring instruments, together with sources of current supply and the container, is 361.3 kilograms.

Scientific measuring stations located in various parts of the Soviet Union are conducting observations of the first interplanetary flight. The determination of the elements of the trajectory is being done by electronic computers according to measurement data which are being automatically received at a coordinating and computing center.

The processing of the results of measurements will make it possible to obtain data about the movement of the cosmic rocket and to determine the areas of the interplanetary space in which scientific observations are being carried out. * * *

Moscow, Tass, Radioteletype in Russian to Europe, January 3, 1959, 0153 G.m.t.

[Text]

Moscow.—The Soviet cosmic rocket continues its flight toward the Moon. At 0300 hours Moscow time on January 3, the rocket was over the Indian Ocean, over a point of the Earth's surface of latitude 3°12′ S. by longitude 108° E., at a distance of over 100,000 kilometers from the Earth.

Observation posts situated on the territory of the U.S.S.R. are making continuous recordings of the signal from the cosmic rocket. The radio signals are broadcast on frequencies of 19.997, 19.995, 19.993, and 183.6 megacycles.

The apparatus aboard the cosmic rocket is working normally. Measurement results show that temperature and pressure in the container with the scientific apparatus is maintained within the required limits.

Moscow, Tass, Russian Hellschreiber to Europe, January 3, 1959, 0435 G.m.t.

[Text]

Moscow.—The Soviet cosmic rocket continues its flight toward the Moon. The processing of the results of trajectory measurements has shown that the rocket has exceeded the second cosmic speed. Thus, for the first time in the history of mankind, the second cosmic speed, which insures entry into interplanetary space, has been achieved and exceeded.

At 0600 hours Moscow time the rocket was over a spot of the Earth's surface with the coordinates latitude 4°30′ S. and longitude 63°30′ E. at a distance of over 137,000 kilometers from the surface of the Earth.

All radio transmitters on board continue to operate reliably and to insure certain reception of their signals by stations on the Earth. Scientific instruments on board the rocket are working normally. The information received from the rocket is being processed and analyzed.

Moscow, Tass, Radioteletype in Russian to Europe, January 3, 1959, 0740 G.m.t.

[Text]

Moscow.—According to the latest data the Soviet cosmic rocket launched toward the Moon has reached an altitude of 175,000 kilometers, a Tass correspondent was told by Aleksandr Topchiev, vice president of the U.S.S.R. Academy of Sciences. Academician Topchiev added that all scientific instruments are functioning perfectly. A colossal amount of information has been received, said Academician Topchiev.

Prague, CTK, Radioteletype in English to Europe, January 3, 1959, 0903 G.m.t.

[Text]

PRAGUE.—The radio signals of the Soviet Moon rocket were registered in Czechoslovakia for the first time on January 3, 1959, at 0459 hours at the ionospheric station of the geophysical institute of the Czechoslovak Academy of Sciences at Panska Ves. Shortly afterward they were also received by Bredirch Micka, an amateur radio operator. At that time the rocket was in a relatively unfavorable location for Czechoslovakia, a distance of about 137,000 kilometers over the equatorial part of East Africa.

Moscow, Tass, in Russian Hellschreiber to Europe, January 3, 1959, 0946 G.m.t.

[Text]

Moscow.—The Soviet cosmic rocket has reached a height of more than 200,000 kilometers and has thus covered one-half of the distance to the Moon, a Tass correspondent has learned from Academician Aleksandr Topchiev, vice president of the U.S.S.R. Academy of Sciences. This took place at 1200 hours Moscow time.

* * * * * * *

Soviet observation stations are successfully fixing signals from the Moon rocket. Academician Topchiev pointed out that the very fact that the Soviet rocket had reached the above height testifies to the accuracy of the calculations carried out before its launching.

Warsaw, PAP, Radioteletype in English to Europe, January 3, 1959, 1100 G.m.t.

[Text]

The first man in Poland to receive and to record on a tape recorder the signals transmitted by the Soviet Moon rocket was Stefan Filipkiewicz, the operator on duty of the Polish radio monitoring service.

Jerzy Burdulak, chief of the monitoring center, told a PAP repre-

sentative that the signals from the Soviet Moon rocket had been received at 2035 hours today in the 19.99- and 108.6-megacycle bands. The signals, consisting of fairly regular "beep beep," will be heard today by Polish radio listeners during the "News From Home and Abroad" broadcast.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 1245 G.m.t

[Text]

Moscow.—By 1300 hours Moscow time today the Soviet Moon rocket was 209,000 kilometers out into space. At that time it was above South America at a point longitude 40° W. and latitude 7° 33′ S

Processed observations of the rocket's movement show that it will pass near the Moon to become the first manmade planet; that is, an artificial satellite of the Sun. Its closest approach to the Moon is calculated at 6,000 to 8,000 kilometers. The rocket's instruments are functioning normally, relaying scientific information to receiving stations on the Earth. The first readings from the rocket show that the temperature of its skin is 15° to 20° C. above zero.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 1445 G.m.t.

[Text]

Moscow.—The Soviet space rocket will not be a lunar satellite, a Tass correspondent was told by Academician Anatoly Blagonravov, who heads the technology department of the U.S.S.R. Academy of Sciences. The scientist explained that the rocket is too fast to be captured by lunar gravitation pull. The rocket will bypass the Moon and continue its flight in cosmic space within the bounds of the solar system.

* * * * * * *

The main purpose of the Moon shot, Blagonravov said, is to obtain fundamentally new scientific data on cosmic rays unaffected by the Earth's magnetic field and also new information about the composition of interplanetary substance. The rocket is provided with extremely accurate Soviet-made instrumentation which will permit us to determine whether the Moon has a magnetic field and the radioactive properties of its surface.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 1605 G.m.t.

[Text]

Moscow.—The Soviet space rocket has left a visible trace on its course, a Tass correspondent was told by Aleksandr Nesmeyanov, president of the U.S.S.R. Academy of Sciences. An automatic device clicked on at a set time ejecting a luminescent cloud of sodium steam—an artificial comet observed by astronomers of many countries.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 1722 G.m.t.

[Text]

Moscow.—At 1600 Moscow time today the Soviet Moon rocket was above the territory of Peru (terrestrial coordinates: latitude 8°20′ S. and longitude 86° W.), 237,000 kilometers from the Earth and 131,000 kilometers from the Moon. At 1,300 Soviet scientific stations conducting observations of the probe lost radio contact with the rocket obscured by the body of the Earth.

The rocket will continue to move in a westerly direction over the Pacific where it can be easily observed from North and South America. It is estimated that at 1900, 2100, and 2400 hours on January 3 the Moon rocket will be over points of latitude 8°57′, 9°18′, and 9°45′ S., and longitude 131° and 160° W. and 155° E., respectively. Its distance from the Earth will be 265,000, 284,000, and 311,000 kilometers, respectively.

At 0100 hours Moscow time on January 4 Soviet scientific stations will be able to resume observations and receive scientific information from the rocket as it will emerge from behind the horizon in the east.

The rocket's equipment and transmitters are functioning normally.

Peking, NCNA, in English Hellschreiber to Europe, January 3, 1959, 1910 G.m.t.

[Text]

NANKING, JANUARY 3.—Signals emitted by the Soviet space rocket from more than 200,000 kilometers off the Earth have been picked up by the Tsuchinshan (Purple Mountain) Observatory of the Chinese Academy of Sciences in Nanking.

Using a No. 12981 receiver, the observatory began to pick up the signals at 1925 this evening in the vicinity of 19.993 megacycles. The signals came from the direction of the Moon. The signals were of variable duration of the order of 0.5 to 0.9 seconds. Later, the signals were also monitored by the No. 13021 receiver of the same type. For more than 1½ hours they continued with little interruption. The signals have been recorded.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 1913 G.m.t.

[Text]

Moscow.—It is now fully clear that the Soviet Moon rocket will become a satellite of the Sun, the first artificial planet, Aleksandr Topchiev, vice president of the U.S.S.R. Academy of Sciences, stated tonight in an interview given to Tass.

The velocity and direction of the flight make it possible to say with confidence that the bond of terrestrial gravitation has been broken and the spaceship will never again fall back on the Earth.

According to data of Soviet tracking stations, by 2100 hours Moscow time the Moon rocket reached an altitude of 284,000 kilometers, moving at a speed of approximately 9,000 kilometers per hour. Thus it has covered almost 80 percent of the distance separating the Moon from the Earth.

Moscow, Tass, in English Hellschreiber to Europe, January 3, 1959, 2130 g.m.t.

[Text]

Moscow.—The Soviet Moon rocket, which is to become the first artificial satellite of the Sun, will follow an orbit with the biggest diameter of 343.6 million kilometers and will have a rotation period of 15 months. According to preliminary estimates of the coordination-computing center, the new planet's orbit will be close to a circle with an eccentricity of 0.148. Its transverse axis will form an angle of 15° with that of the Earth, and the plane of the rocket's orbit will practically coincide with that of the orbit of the Earth. The planet's closest approach to the Sun, at the perihelion, will be on January 14, 1959, and will amount to 146.4 million kilometers. Its farthest departure from the Sun, at the aphelion, will be 197.2 million kilometers and will be reached early in September 1959.

The trajectory of the Soviet cosmic rocket is being plotted with the help of radiotechnical systems which have made it possible to obtain exact information about its movement and which make long-term forecasts, determining specifically the artificial planet's future orbit.

The computing center continues to digest the extensive information received on changes in the rocket's trajectory and to specify the parameters of its movement.

Moscow, Tass, Radioteletype in Russian to Europe, January 4, 1959, 0110 G.m.t.

[Text]

Moscow.—At 2036 on January 3, scientific observation stations situated in the eastern part of the Soviet Union resumed reception of radio signals from the Soviet cosmic rocket on the frequencies 19.993, 19.995, and 19.997 megacycles. Reception started considerably earlier than the rocket's appearance from behind the horizon. At 0030 on January 4 the reception of radio signals was resumed on the frequency of 183.6 megacycles. Scientific apparatus and radio transmitters on board the rocket continue to function normally. Information received testifies to the fact that the rocket is continuing its flight along the set trajectory in the direction of the Moon.

On January 4, at 0300 Moscow time, the rocket was 336,600 kilometers from the Earth, above the Indian Ocean, south of the island of Java, at a spot of the Earth's surface with coordinates of longitude 110° E. and latitude 10°7′ S. The rocket is moving toward the Moon. At 0559 hours Moscow time the rocket will pass in direct proximity to the Moon at a distance of 7,500 kilometers from the Moon's surface.

The rocket will be at a distance of 370,000 kilometers from the center of the Earth.

In subsequent movements the rocket, receding from the Moon, will gradually go into its orbit of a planet of the solar system. The scientific information from the cosmic rocket continues to arrive in accordance with the planned program of measurements.

Moscow, Tass, Radioteletype in Russian to Europe, January 4, 1959, 0300 G.m.t.

[Text]

Moscow.—On January 4, at 0559 hours Moscow time, the Soviet cosmic rocket passed the nearest point to the Moon on its trajectory. Instruments and transmitters of the rocket continue to work normally and are reporting valuable scientific material to the Earth receiving stations.

The scientific tasks set before the launching of the cosmic rocket have been completely carried out.

In connection with the increasing recedence from the Earth, as well as the exhausting of sources of feeding, radio contact with the cosmic rocket will gradually deteriorate and possibly within the next 24 hours will cease.

At the present moment the cosmic rocket is slowly moving along the sky and is still in the constellation of Virgo. A 0701 hours Moscow time the declivity of the rocket will be minus 10.8° and its direct ascent 14 hours 14 minutes.

By 0900 hours the cosmic rocket will be over Angola, South Africa, above a point having coordinates of longitude 20° E. and latitude 11°25′ S. at a distance of 390,000 kilometers from the Earth.

As the cosmic rocket recedes from the Earth and the Moon their influence on the rocket's movement will weaken. The movement of the rocket will, to an ever-increasing degree, be determined only by the force of attraction of the Sun. The rocket will enter into its final elliptical orbit around the Sun, thus becoming the very first artificial planet of the solar system. In practice this will occur as from January 7 to 8.

The results of experimental observations obtained with the aid of the Soviet cosmic rocket will be published as soon as they are processed.

Moscow, Tass, in English Hellschreiber to Europe, January 4, 1959, 1310 G.m.t.

[Text]

Moscow, January 4.—At 1200 hours Moscow time on January 4 the Soviet space rocket continued to recede from the Moon and the Earth and was 422,000 kilometers from the center of the Earth and 60,000 kilometers from the center of the Moon. The space vehicle continues its flight away from the Moon and Earth, gradually emerging onto its elliptic orbit around the Sun.

At 1200 hours Moscow time the bearings of the space rocket were: Direct ascent 14 hours 15 minutes; declination minus 12°. The ground

tracking stations of the Soviet Union continued to receive signals from the space rocket.

As established, the temperature of the rocket's skin is plus 10° to 15° C. The temperature of the equipment and of the gas within the instrumentation container is, in different points, within the limits of plus 10° to 15° C., which is enough for the normal functioning of the instruments.

When the Soviet space rocket passed in the neighborhood of the Moon on January 4 the tracking stations of the Soviet Union continued measuring the parameters of its movement. Measurements of the rocket's radial speed when passing the Moon permitted the determination at 0557 hours Moscow time on January 4 the local maximum value of this speed: 2.45 kilometers per second, which accords with the data related to the other trajectory measurements taken when the rocket was nearest to the Moon. Thus, in less than 1.5 days—34 hours—the spaceship covered a distance of 370,000 kilometers from the Earth to the Moon.

Moscow, Tass, in Russian Hellschreiber to Europe, January 4, 1959, 2015 G.m.t.

* * * At 2200 hours, January 4, the Soviet cosmic rocket was 510,000 kilometers from the Earth. The coordinates at this time were: direct ascension, 14 hours 17 minutes; declination, −14°15′.

The distance of the rocket from the Moon at 2200 hours January 4 was 180,000 kilometers. The rocket continues to move away from the Earth and the Moon.

At 1300 hours today, as a result of the revolution of the Earth, the rocket left the zone of visibility for the observation stations situated on the territory of the Soviet Union. It is again due to enter this zone at 0100 hours January 5.

Moscow Radio, Soviet Home Service, January 5, 1959, 0600 G.m.t.

[Excerpt from Pravda article]

* * * On January 3, 1959, at 0357 hours Moscow time, before dawn, a new astonishing comet of unusual origin appeared in the night sky between the first three stars—the three alphas of the constellations of Virgo, Bootes, and Libra. It was simultaneously discovered by many observatories throughout the world. In the course of 3 short minutes it was observed, photographed, and studied and the line typical of sodium was recorded in special analysis.

Moscow, Tass, Radioteletype in Russian to Europe, January 5, 1959, 1525 G.m.t.

[Text]

Moscow.—We are transmitting a Tass statement on the flight of the Soviet space rocket.

The Soviet space rocket is continuing its flight. On January 5 the signals received from the rocket have considerably weakened. In view of the exhaustion of the sources for feeding it, reliable radio

communication with the rocket ceased on January 5 at about 1000 hours Moscow time.

The space rocket, in 62 hours of its flight since launching by 1000 hours Moscow time January 5 moved away from the Earth 597,000 kilometers. On this path, 34 hours since starting it passed near the Moon and, overcoming the gravity of the Earth and the Moon, is entering into orbit around the Sun.

For 62 hours, in accordance with the program, reliable radio communication between the rocket and Earth was maintained, which enabled observation of the movement of the rocket and reception of information on the operation of scientific instruments on board the rocket. The program for observation of the space rocket and the program of scientific investigation are completed.

The space rocket will finally enter a periodic orbit as an artificial planet on January 7–8 this year. The elements of this orbit were reported earlier. The orbit of the artificial planet is situated between the orbits of the Earth and Mars. The smallest distance between the orbits of the artificial planet and Mars is 15 million kilometers, which is approximately four times less than the distance between the Earth and Mars at the time of greatest apposition of Mars.

Moving on its orbit around the Sun every 447 full Earth days, the artificial planet will again get nearer to the Earth in about 5 years. However, its distance to the Earth will be some tens of millions of kilometers.

Moscow, Tass, January 5, 1959, 1826 G.m.t.

(Tass amended the period of revolution from 447 days to 450 days.)

Moscow, Tass, in English Hellschreiber to Europe, January 6, 1959, 1430 G.m.t.

* * * * * * *

Speaking of the objectives Soviet scientists had set themselves in launching the rocket, Blagonravov emphasized that the hitting of the Moon was not their goal. The rocket's flight in the vicinity of the Moon made it possible, as we expected, he said, to obtain more information than we could have obtained by having the rocket land on the Moon. Whether it is more important in terms of a sensation for a rocket to hit the Moon or to become an artificial planet is a debatable point, Blagonravov said.

Academician Blagonravov emphasized that the successful launching of the Soviet lunar rocket was the first attempt of this kind ever made in the U.S.S.R. Asked whether it had been preceded by unsuccessful launchings, he said it had not. He also replied in the negative to the question about experimental flights of manned rockets to high altitudes alleged to have taken place in the Soviet Union * * *.

Moscow, Tass, in English Hellschreiber to Europe, January 11, 1959, 2245 G.m.t.

[Text]

Moscow.—Pravda today publishes a detailed statement on the Soviet space rocket which has become the first artificial planet of the solar system * * *.

The statement emphasizes that the scientific equipment installed on board the rocket functioned normally. A large amount of records of measurements have been obtained and are now being sifted and generalized. A preliminary analysis shows that the investigations are of great scientific importance. These results will be published as they become available.

* * * * * * *

For the space flight a multistage rocket was made, distinguished by a high level of design with very effective rocket engines. A special automatic system guided the flight of the rocket along the set trajectory with great precision * * *.

* * * * * * *

The last stage of the cosmic rocket is guided by an automatic system stabilizing the position of the rocket at a set trajectory and insuring the designed speed at the end of the functioning of the engine. After the consumption of the space fuel, the last stage weighs 1,472 kilograms. Besides the facilities insuring the normal flight of the last stage of the rocket, its body contains an airtight removable container with scientific and radio-engineering apparatus; two transmitters with aerials working on frequencies of 19.997 megacycles; a cosmic ray counter; a radio system determining the trajectory of the flight of the rocket and predicting its further movement; and apparatuses for forming an artificial natrium comet.

The container is located in the upper part of the last stage of the cosmic rocket and is protected against heat while passing the dense layers of the atmosphere by a jettisonable cone. The container consists of two airtight interconnected spheric thin half cases. One of them bears four rods of the aerials of the radio transmitter. The aerials are fixed on the body symmetrically with regard to the empty aluminum spike at the end of which the terrestrial magnetic field meter and the lunar magnetic field detector are installed. The aerials are opened after the jettisoning of the protection cone. The same half of the case contains two proton counters to detect the gas components of interplanetary substances and two piezoelectric meters for studying meteoric particles. The half cases are made of a special aluminum magnesium alloy.

The container is filled with gas at a pressure of 1.3 atmospheres. Its temperature is maintained at about 20° C. Such conditions are insured by a definite coefficient of reflection and radiation of the case which is achieved by its special processing. Compulsory circulation of the gas is secured by a ventilator. The gas circulating in the container collects the heat from the instruments and transfers it to the case which functions as a kind of radiator.

Two pennants with the coat of arms of the Soviet Union have been set up on the rocket. Both are inside the container. One pennant is made in the form of a thin metal ribbon. One side bears the inscrip-

tion: "Union of Soviet Socialist Republics," the other depicts the coat of arms of the Soviet Union and bears the inscription, "January 1959." The inscriptions have been made by special photochemical method which insures their preservation for a long time.

The second pennant has a spherical form. The surface of the sphere is covered with pentagonal elements of special stainless steel. One side of each element has the engraved words "USSR January 1959," the other side the coat of arms of the Soviet Union and the inscription "USSR."

A great complex of measuring facilities throughout the territory of the Soviet Union was used to observe the flight of the space rocket, to measure the parameters of its orbits, and to receive from abroad the rocket data on scientific measurements. Among these facilities were a group of automated radar installations for the precise determination of the elements of the early part of the orbit; a group of radiotelemetric stations to register scientific information transmitted from the rocket; a radio engineering system for controlling the elements of the rocket's trajectory at great distances from the Earth; radioengineering stations for receiving signals, and optical means for observing and photographing the artificial comet.

The data are being sifted and centralized by the coordinating and computing center by means of electronic computing machines. In spite of unfavorable weather in most areas with optical means for observations of the space rocket, several photographs of the natrium comet have been taken. It has been possible to define more precisely the elements of the rocket's orbit and to control directly the movement of the rocket in space. The use of powerful ground transmitters and highly sensitive receiving faculties insured reliable measurements of the trajectory of the space rocket up to distances of some 500,000 kilometers. The multistage cosmic rocket was launched from the Earth's surface vertically. Operating by the programed mechanism of the automatic system guiding the rocket, its trajectory gradually deviated from the vertical direction.

The rocket rapidly gathered speed. At the end of the takeoff boost the last stage of the rocket had gathered a speed necessary for its further movement. The Soviet space rocket exceeded the second astronautical speed at the moment when the rocket engine of its last stage was switched off.

About 1 hour after the start the rocket entered the Berenice's Hair constellation on the heavenly sphere. The rocket then entered the Virgin constellation, in which it came closest to the Moon. While bypassing the Moon the rocket was in the heavenly sphere between the star of Spica and Alpha of Balance. Close to the Moon the rocket moved along a heavenly sphere about five times slower than the Moon, which, moving along its orbit around the Earth, proceeded to the point of contact with the rocket from the right if seen from the Northern Hemisphere. The rocket approached from this point from above and from the right. In the period of its closest distance from the Moon the rocket was higher and slightly to the right of the Moon.

It was calculated that the bypassing of the Moon by the rocket could be observed by radio facilities in the U.S.S.R. and other European countries, as well as in Africa and a great part of Asia.

The cosmic rocket took 34 hours to attain the vicinity of the Moon. According to more precise data, the closest distance between

the rocket and the Moon was 5,000 to 6,000 kilometers or about one and a half diameters of the Moon. At a distance of about 1 million kilometers from the Earth, the Earth's gravity affected the rocket so slightly that one can consider that the rocket moved only under the influence of the force of attraction of the Sun.

On or about January 7–8, the Soviet space rocket entered its independent orbit around the Sun, became its sputnik, the world's first artificial planet of the solar system. The speed of the movement of the rocket, like planets, around the Sun was at that time about 32 kilometers a second.

Moscow, Tass, in English Hellschreiber to Europe, January 12, 1959, 0030 G.m.t.

[Text]

An artificial natrium comet was used for optical observation of the space rocket from the Earth with the object of confirming the fact that the rocket proceeded along the given part of its trajectory.

This comet was formed on January 3 at 0557 Moscow time at a distance of 113,000 kilometers from the Earth. The observation of the artificial comet was possible in central Asia, the Caucasus, the Middle East, Africa, and India. Photographs of the comet were taken by means of specially designed optical equipment installed at southern observatories of the U.S.S.R. The time for forming this artificial comet was selected so as to make it visible to the greatest possible number of observation posts in the Soviet Union.

Special equipment was installed in the last stage of the space rocket in order to form the natrium comet. A natrium vaporizer made it possible to vaporize 1 kilogram of natrium within 5 to 7 seconds and to create a natrium cloud in conditions of the weightlessness and profound vacuum of cosmic space.

Moscow Radio, Soviet Home Service, January 12, 1959, 0600 G.m.t.

[Text]

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THE FLIGHT OF THE COSMIC ROCKET

The multistage cosmic rocket left the Earth's surface vertically. Under the action of the program mechanism of the automatic system which controlled the rocket, its trajectory was gradually deflected from the vertical. The speed of the rocket increased rapidly. At the end of the acceleration run, the rocket's last stage acquired a speed necessary for its further flight. The automatic control system of the last stage switched off the rocket motor and gave the order for the separation of the container with the scientific instruments from the last stage of the rocket. The container and the rocket's last stage entered the trajectory and began the movement in the direction of the Moon, the two being close together.

Statement by President Eisenhower on Soviet Rocket, January 3, 1959

The successful launching as announced by the Soviets of a vehicle designed to pass near the Moon represents a great stride forward in man's advance into the infinite reaches of outer space.

To the scientists and engineers assigned to the undertaking a full measure of credit is due, and we congratulate them on this achievement.

Statement by Prime Minister Macmillan on Soviet Rocket, January 4, 1959

Please accept my congratulations on an outstanding achievement. It will, I am sure, make an important contribution to man's scientific knowledge. British scientists join me in congratulating their Soviet colleagues and all those concerned in this project.

Summary of Soviet Rocket Experiments

Vertical Rocket Flight

Date of vertical flight	Number of dogs	Altitude (miles)	Number of flights
1949–52 (used pressure suit without sealed cabin)	9	60	6–12
1952–57 (used pressure suit without sealed cabin)	12	65	9–18
1957–58 (used sealed cabin at 1 atmosphere)	5	60–130	5–12(?)
Aug. 27, 1958	2	270	1
July 2, 1959	[1] 2	300(?)	1
July 10, 1959	2	300(?)	1
Total			[2] 23–44

[1] Also 1 rabbit.

[2] Because 1 of the dogs on the July 10, 1959, flight had been sent up 3 previous times, including July 2, 1959, the probabilities are that the table understates the total number of Soviet dog-flight tests.

DATA RECEIVED

Preflight (1–2 days before launching)

1. Electrocardiograms.
2. Blood analyses.
3. Pulse rate (95–160 per minute)
4. Urinalysis.

Vertical flight

1. Partial and complete weightlessness (3.7 minutes)
2. Maximum and minimum blood pressure values.[1]
3. Pulse rate (increase and decrease).[1]
4. Respiration rate.[1]
5. Body temperature.[1]
6. Pressure variables inside compartment (640 mm. down to 18 mm. Hg until separation of rocket nose section 188 seconds or 3 minutes).
7. G-stress on reentry.[1]
8. Stabilization.
9. Six liters per minute of O_2 feed in pressure suits (2–3° temperature) variance.
10. Safety reserve of pressure suit not less than 2½–3 pounds per square inch.
11. G-load:
    (a) Acceleration (transverse) 5G–100 seconds.
    (b) Deceleration (variable axis) 5G–40 seconds.

[1] Telemetered data.

12. Ascending trajectory speed, 1.72 kilometers per second.
13. Descending trajectory, 1.75 kilometers per second.

Postflight (1 day after flight)

1. Electrocardiograms.
2. Blood analyses.
3. Pulse rate (normal).
4. Urinalysis.

RECOVERY (DESCENT IN CATAPULT CRADLE)

1. Radius 3–70 kilometers (1.8–42 miles) from launching site.
2. Three to eight hours after launching.
3. Parachuting: (*a*) Increase or decrease of 2–5 respirations per minute.

TRAINING (CONDUCTED DAILY FOR SEVERAL MONTHS)

1. Two-hour stay in pressure suit (attitude behavior and neurological).
2. Twice daily feeding schedule.
3. Catapulting of carriage with dogs under ground condition.
4. Pressure helmets.
5. Vibrastand.
6. Hermetically sealed cabin.
7. Absolute and excessive pressure in regard to the suit.
8. Capsule space (0.28 m^3).

SPUTNIK II ORBITAL FLIGHT (LAIKA), NOVEMBER 3, 1957

Perigee: 140 miles (18,000 miles per hour).
Apogee: 1,038 miles (15,000 miles per hour).
Orbit time: 103.75 minutes.

Remarks

Number of dogs selected for complete training: (*a*) 10 dogs selected (weight about 6 kilograms); (*b*) "Laika" ("Barky") selected from this initial group for Sputnik II orbital flight (female, 2 years old, weight 6 kilograms).

Biological data, preflight orbital training

1. Gradual training of dogs for protracted and confined trip in small cabin.
   (*a*) Accustomed to laboratory furnishings.
   (*b*) Confinement in special cages.
2. Size of cages gradually diminished, finally approximating that of airtight satellite cabin.
3. Confinement increased from hours to 15–20 days.
4. Animal adaptation to accouterment and fittings for registering physiological functions.
5. Training of animal for defecation and urination during 20-day confinement.
6. Tolerance to noise of operating assembly.
7. Caloric measurements and general food composition.
8. Measurement of energy requirements (varied within limits of 400–650 calories per day).
9. One hundred grams per day of pressed food (40 percent bread crumbs, 40 percent powdered meat, and 20 percent beef fat) during initial experimental feeding period of 20 days.
10. Measurement of water consumption (average 120 milliliters and not more than 200 milliliters per day).
11. Selection of final gelatinous food mixture (basic nutrients, water, and agar-agar).
12. Combined effect of acceleration, noise, and vibration.
13. Tolerance to vibration loads up to 10 g.
14. Vibration caused greater functional changes than did sound.
15. Acceleration (chest-spine direction), 2 to 10 g "overload" for 6–15 minutes.
   (*a*) Increased saliva excretion
   (*b*) Pulse rate increased 1.5–2 times normal
   (*c*) Respiratory rate increased 1.5–3 times normal
   (*d*) Arterial pressure increased 50–80 mm. Hg.

Biological data (orbital)—Qualitative reference reported by Soviets

1. Changes in both intensity and composition of radiation without data.[1]
2. Electrocardiogram (thoracic lead, indwelling electrodes).[1]
3. Barometric pressure of air in cabin.[1]
4. Temperature at various points in sealed cabin.[1]
5. Respiratory measurements.[1]
6. Arterial blood pressure (cuff-oscalator).[1]
7. Control of air pressure (sleeve of pickup).[1]
8. Measurement for presence, duration, and amount of animal movement (actogram).[1]
9. Measurements of G-stress.[1]
10. Combined effect of acceleration, noise, and vibration.
11. Complete weightlessness.
12. Central nervous system changes.
13. Functional changes affecting blood circulation and respiration.
14. No explosive decompression; adequate construction prevented mechanical damage by meteoric material.

Biological data and instrumentation

1. Cylindrical sealed container—640 millimeters (diameter) and 800 millimeters (length) with removable cover and inspection hatch.
2. Food and water supply—3 liter metal container.
3. Seven-day ration—gelatinous material containing necessary amount of water and nutritive ingredients (automatic feeder trough and water dispenser).
4. Measurement of respiratory rate using strain—gage indicators with resistance from 0.3 to 25 k. Ohm.
5. Amplifier—commutation unit with 3,000 as coefficient of amplification.
6. Restraining cloth suit for actual flight.
7. Rubber sanitary arrangement attached to airtight "latrine" reservoir. Activated carbon and specially dried moss for deodorization and absorption.
8. Sealed cabin constructed of aluminum alloy (interior and exterior).
9. Seven-day programing of air regeneration system.
10. Ventilation (small dimensional electric motors).
11. Controlled animal body heat (special heat-conducting screen).
12. Controlled pressure relay (no rise above 765 millimeters Hg permitted).
13. Control of cabin temperature above +15°C. (twin thermo-relay).
14. Temperature indicators and checks for ventilation (wire rheostats and potentiometers).
15. Radio apparatus for ground relay.
16. Instrument for study of ultraviolet and X-rays from sun.
17. Protracted laboratory testing of instrumentation under vibratory and accelerative conditions.

American Lunar Probe Experiments

During fiscal year 1959, five lunar probe attempts were scheduled—three by the Air Force and two by the Army, all from Cape Canaveral, Fla. These were initially under the cognizance of the Advanced Research Projects Agency, and then were transferred to the National Aeronautics and Space Administration after it became operational at the beginning of October 1958.

The Air Force experiments used a Thor-Able booster. This has an approximate gross weight at takeoff of 112,000 pounds. The first stage Thor booster uses a single rocket engine rated at 150,000 pounds of thrust. The second stage is a modification of the Vanguard second stage, and delivers about 7,500 pounds of thrust. Both of these stages are liquid fueled. The third state is a solid fuel Allegany Ballistics unit rated at about 2,500 pounds thrust. The payload

[1] Telemetered data.

NOTES.—Quantitative data—analysis of electrograms (7 separate recordings)—withheld by Soviets. Laika apparently died of anoxia.

carried a small fourth stage solid-fueled retro rocket. This final stage weighed 83.8 pounds, including 25 pounds of instruments. Toroidal in shape, it was 29 inches in diameter and 30 inches long. It carried mercury batteries to give the transmitter a 10-day lifetime.

The first launching attempt on August 17, 1958, required destruction 77 seconds after launch because of engine failure in the first stage.

The second attempt, called Pioneer I, was very similar, but had a final stage weight of 84.4 pounds, including 39 pounds of scientific instruments. Launched on October 11, 1958, it rose about 70,700 miles, and reentered the atmosphere to burn up after 43 hours 17½ minutes, somewhere over the South Pacific. A 3½° error in course caused a drop in speed which limited the distance traveled.

The third and final Air Force attempt, called Pioneer II, was similar but the final stage weighed 86.4 pounds, including 34.3 pounds of scientific instruments. The vehicle was launched November 8, 1958, and the flight lasted 42.4 minutes, because the third stage failed to ignite, so that after a climb to 963 miles, it fell over East Africa.

The Army experiments used a Juno II booster. This has an approximate gross weight at takeoff of 121,000 pounds. The first stage Jupiter booster uses a single liquid-fueled rocket engine rated at 150,000 pounds of thrust. The second stage is made up of 11 clustered solid-fueled Sergeant rockets, and the third stage is 3 more Sergeants. The second and third stages in tublike structures spin to stabilize their performance and direction of thrust. The fourth stage, with one Sergeant, had mounted on it a capsule, cone-shaped, 23 inches long and 10 inches maximum diameter. The power supply was mercury batteries for a transmitter life of 90 hours. The final stage capsule weighed 12.95 pounds.

The first Army launching attempt, called Pioneer III, came on December 6, 1958. It rose to a height of 63,580 miles, then after a total flight of 38 hours 6 minutes reentered the atmosphere and burned over French Equatorial Africa. This was because the fuel was cut off 3 seconds too soon in the first stage.

The second Army attempt and final shot of five was called Pioneer IV. Launched on March 3, 1959, it was similar to the one before it, except that the final stage capsule weighed 13.4 pounds. The vehicle reached Earth escape veolcity, passed within 37,300 miles of the Moon, and then automatically assumed its own orbit around the Sun. Pioneer IV was tracked for 82 hours to a distance of 407,000 miles from Earth.