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Directorate of Science and Technology

Office of Scientific Intelligence

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PRELIMINARY ANALYSIS OF LUNA 9

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SUMMARY AND CONCLUSIONS

The success of Luna 9 in soft-landing on the moon and transmitting data back to the earth represents a significant accomplishment in the Soviet lunar exploration program. The numerous unsuccessful efforts that preceded Luna 9 indicate the high priority placed on a lunar landing by the USSR.

Information derived from Luna 9 is valuable to both the United States and the Soviet Union. Luna 9 proved that a vehicle can be successfully softlanded on the moon. This in turn, may lead to some optimism regarding future manned lunar landings.

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In addition, the Soviets said that Luna 9 made radiation measurements and found that the radiation level on the moon is well within the acceptable limits for human beings. The Luna 9 payload appears to be of relatively simple design using subsystems of minimum complexity consistent with achieving its missions.

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DISCUSSION

Previous Launch Attempts

Luna 9 was the twelfth attempted lunar mission* in a program dating back to January 1963. Of the previous 11 attempts, four failed while in their parking orbit, two failed during ejection from parking orbit, two (Luna 4 and 6) missed the moon due to errors in the midcourse maneuver, and three (Luna 5, 7, and 8) crashed on the moon.

Configuration of Luna 9 Spacecraft

According to Soviet announcements, Luna 9 consisted of three basic parts: (1) a "Lunar station" weighing about 220 pounds which was soft-landed on the moon (see figure 1) (2) a propulsion system used both for the midcourse correction and for the soft landing, and (3) two compartments carrying altitude control and guidance systems. The total weight of Luna 9 as it left its earth parking orbit and started on its lunar trajectory was said to be 3,483 pounds. This weight is consistent with those of previous lunar probes [redacted]

The Soviets described the Luna 9 landing capsule as a hermetically sealed sphere which had petal-like legs that unfolded upon impact to stabilize the station on the moon. Radio transmitters and receivers, telemetry equipment, and batteries were contained inside the sphere. The station was said to be about two feet above the lunar surface, but it is not clear whether this figure refers to the diameter of the sphere or to the height of the photofacsimile viewing device above the surface. The photofacsimile sensor itself was said to weigh less than 1.5 kilograms, and its field of view was said to be 30° and centered at 90° to the station's main axis. It reportedly had a large depth of field which allowed imaging at distances from about 7 feet to infinity without changing the focus.

Soviet descriptions of the Luna 9 spacecraft are consistent with the characteristics of an unidentified Soviet spacecraft shown in figure 2. This object appears similar to the sketches in figures 3 and 4, purporting to show Luna 9 enroute to the moon. [redacted]

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* A subsequent attempt on 1 March 1966 failed to eject from parking orbit and was labeled Cosmos 111 by the Soviets.

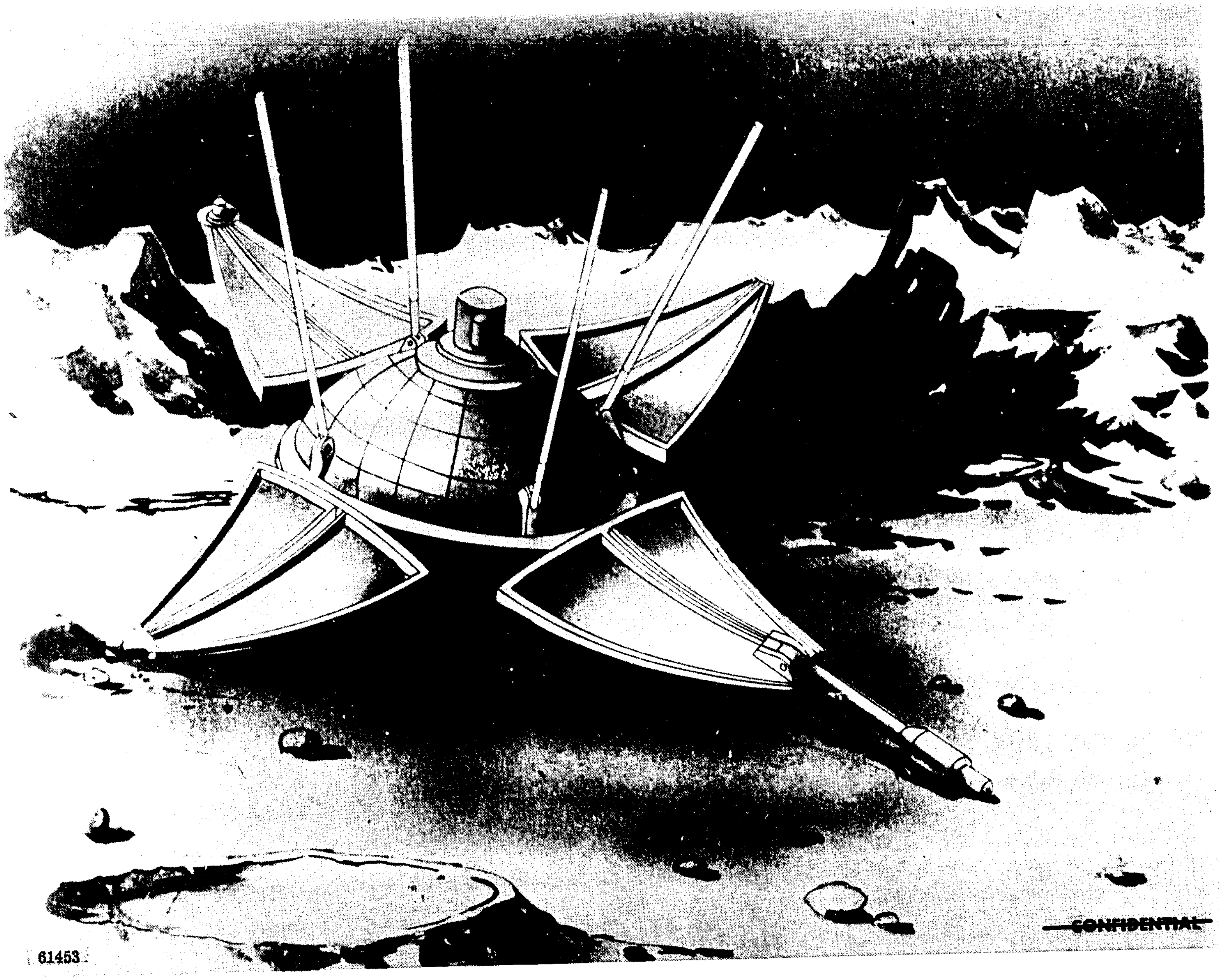

Figure 1. Soviet drawing of lunar station.

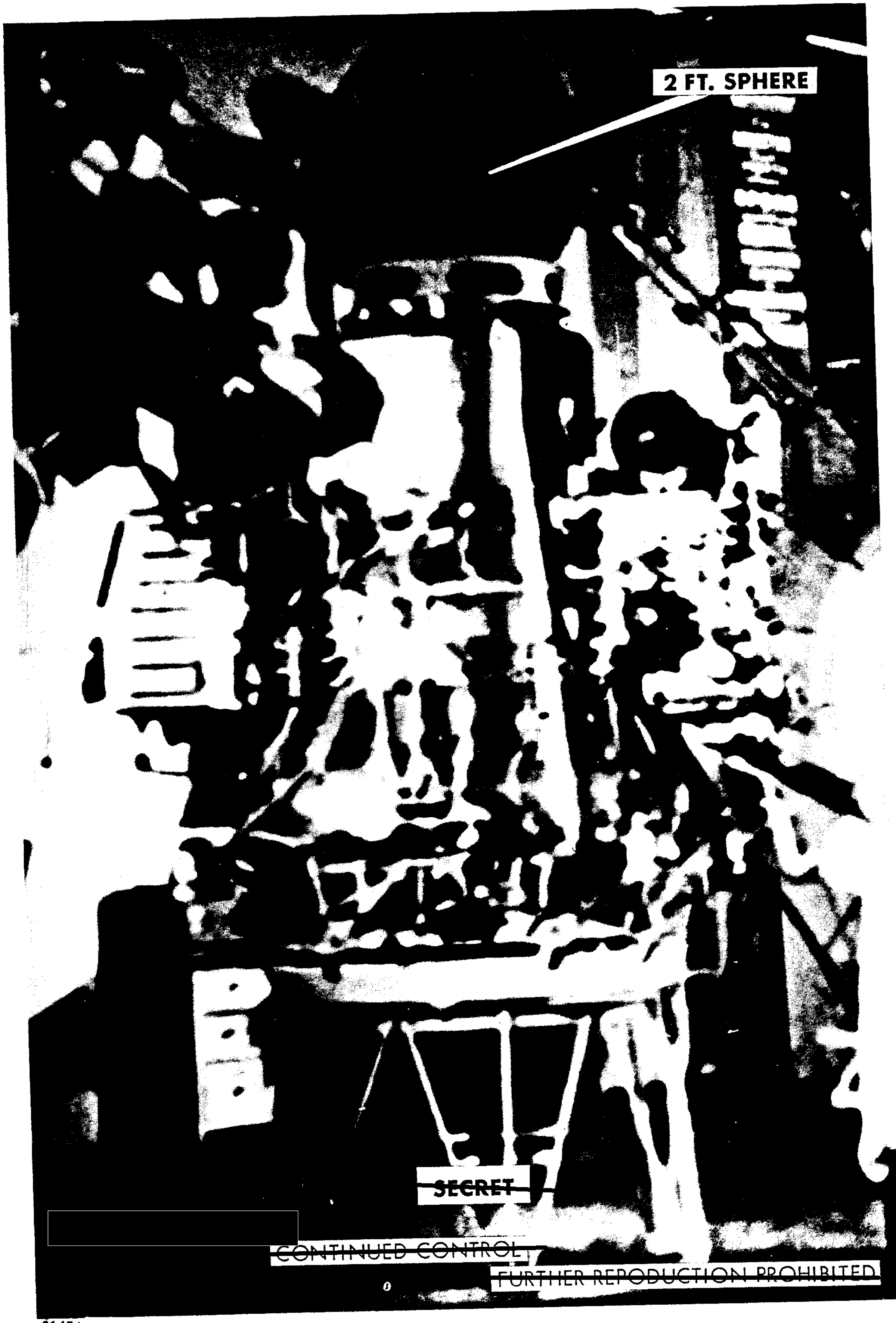

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Figure 2. Possible photograph of a Luna station.

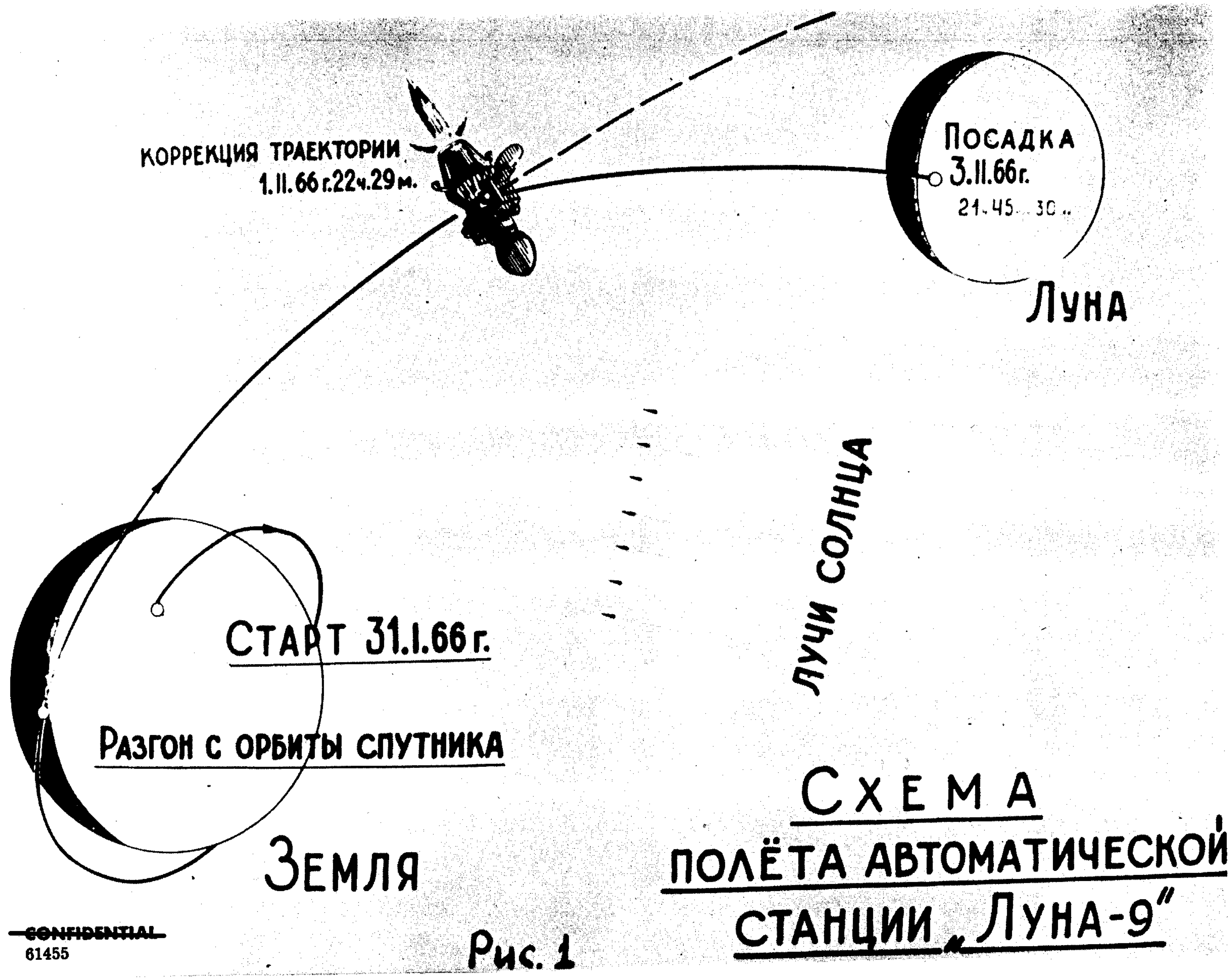

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Figure 3. Soviet drawing of parking orbit and midcourse maneuver.

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A midcourse correction was carried out at 1929Z, 1 February. According to TASS, commands were sent from the ground and the spacecraft oriented itself in the following manner: one sensor was locked onto the sun, and a second sensor searched until it found the moon and locked on to it. The direction of these two sensors with respect to the spacecraft was slowly changed by ground commands until the axis of the midcourse engine was correctly oriented. The midcourse engine was then fired and changed the velocity of the spacecraft by about 234 feet/second. [redacted]

TASS stated that at 1300Z, 3 February, initial data for carrying out the braking sequence were transmitted to the probe. At an altitude of 8300 km above the moon, roughly one hour before impact, the station was aligned with the local vertical (see figure 4) by "optical means" (presumably a lunar horizon sensing device). While in this orientation, the two optical sensors mentioned previously were locked onto the sun and the earth and held them as reference points "for about an hour until the braking engine was fired." This very simple procedure takes advantage of an inherent geometrical property of the group of approach trajectories, and insures that the braking engine is aligned with the local vertical even if the trajectory is slightly off nominal.

Just before ignition of this braking engine, according to the Soviet account, the two compartments containing flight control instruments were jettisoned. These compartments can be seen in figures 3 and 4.

At a height of 75 km, the braking engine was triggered by a radio altimeter (see figure 4) and fired for 48 seconds. This retrofire period reduced the velocity of the probe from "2,600 meters per second to several meters per second at a very low altitude."

At impact, the lunar station with a "system of shock absorbers" was separated from the braking unit and landed nearby. [redacted] Figure 5 shows the sequence of events near landing time. The short period of nearly constant frequency after the end of main retrofire may reflect a vernier descent phase. The TASS-announced impact time of 1845:30Z is probably an approximation since the radio signal was off the air at that time. When the signal returned after landing, its frequency was only slightly different from that immediately before separation of the capsule. This suggests that the same transmitter was used, first with an antenna on the retrounit, and later, after opening of the capsule, with the antennas shown in figure 1.

Missions of Luna 9

In a Moscow press conference on 10 February, Mstislav Keldysh, President of the Soviet Academy of Sciences, stated that the only two missions of Luna 9

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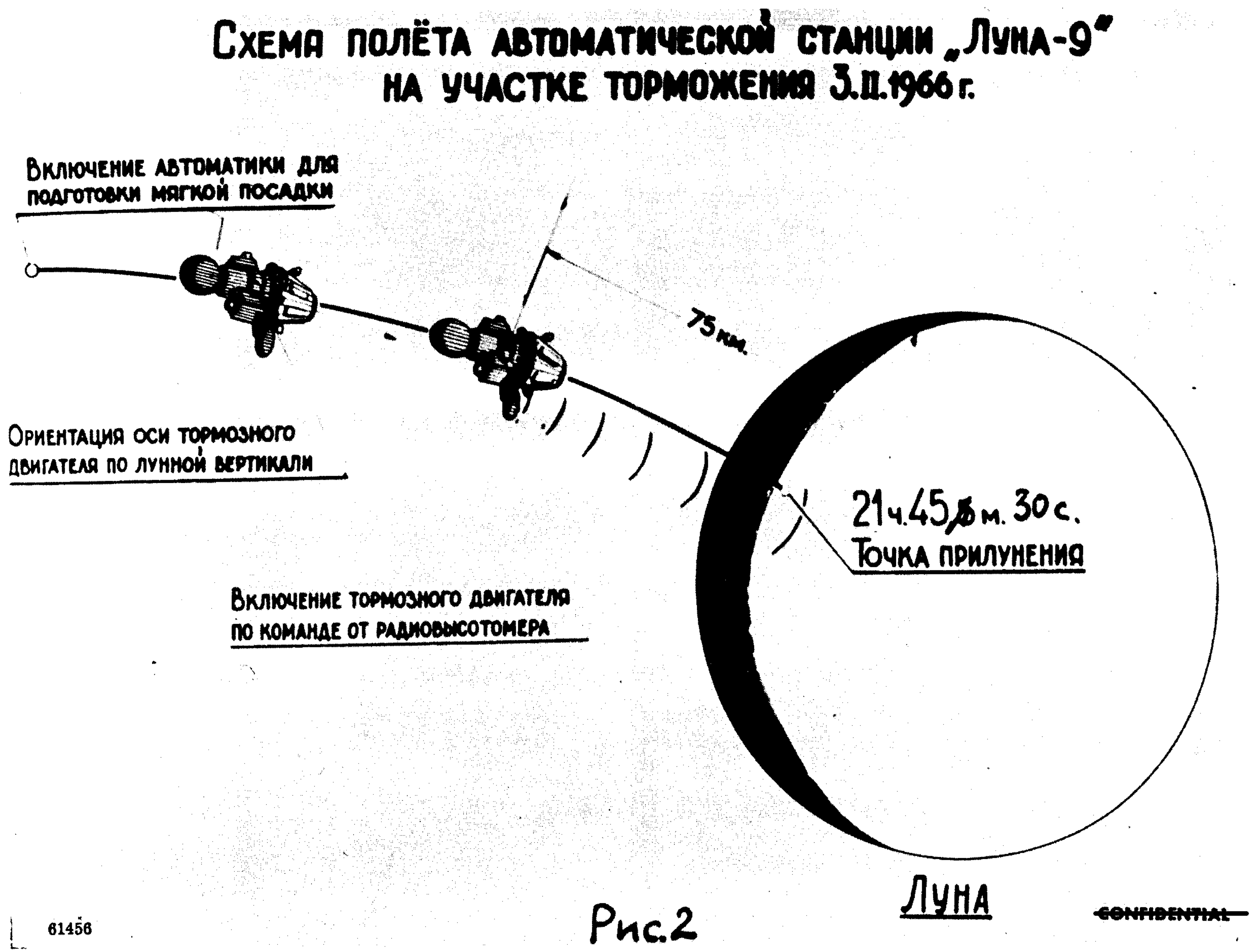

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Figure 4. Soviet drawing of terminal phase of Luna 9.

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were to "photograph the lunar surface and to measure radiation at the lunar surface." Other experiments cannot be ruled out until the scientific telemetry has been analyzed.

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At the press conference, Soviet scientists claimed that the lunar photos showed details of the surface as small as 2 millimeters near the station, and larger features out to the horizon, which was about 1.5 kilometers from the station. During the time of the picture taking, the elevation of the sun changed from about 7° to 43°. This will aid the Soviets in their interpretation of the vertical magnitude of various surface features by a study of the same features under different conditions of illumination. However, the sun did not reach a high enough angle during the period of the experiment to completely illuminate the bottoms of some of the larger depressions. The Soviets therefore will not be able to determine with great accuracy the depths of these features. On the other hand, they received a dividend when the station shifted position slightly between the "second and third" transmissions. Some of these changes can be noted by comparing the lunar panorama shown in figures 7, 9, and 10. By comparing photos of the same features before and after the shift, the Soviets will be able to obtain a slight stereo effect. The cause for the shifting of the station is not known, but Keldysh has stated that the station could have been resting on a small stone or that the surface of the moon could have settled slightly. Such a settling could be due to temperature changes and/or to certain mechanical movements within the station.

In addition to the video experiment, the Soviets also measured radiation at the lunar surface. A Soviet physicist from Moscow State University, A. I. Lebedinsky, stated that signals received from Luna 9 showed that "the intensity of radiation on the surface of the moon is determined mainly by cosmic rays and the dose amounts to 30 millirads per day." This indicates that the interior of the moon probably contributes little if any to the radioactivity at the surface. The most interesting thing about this measurement is that it was made in terms

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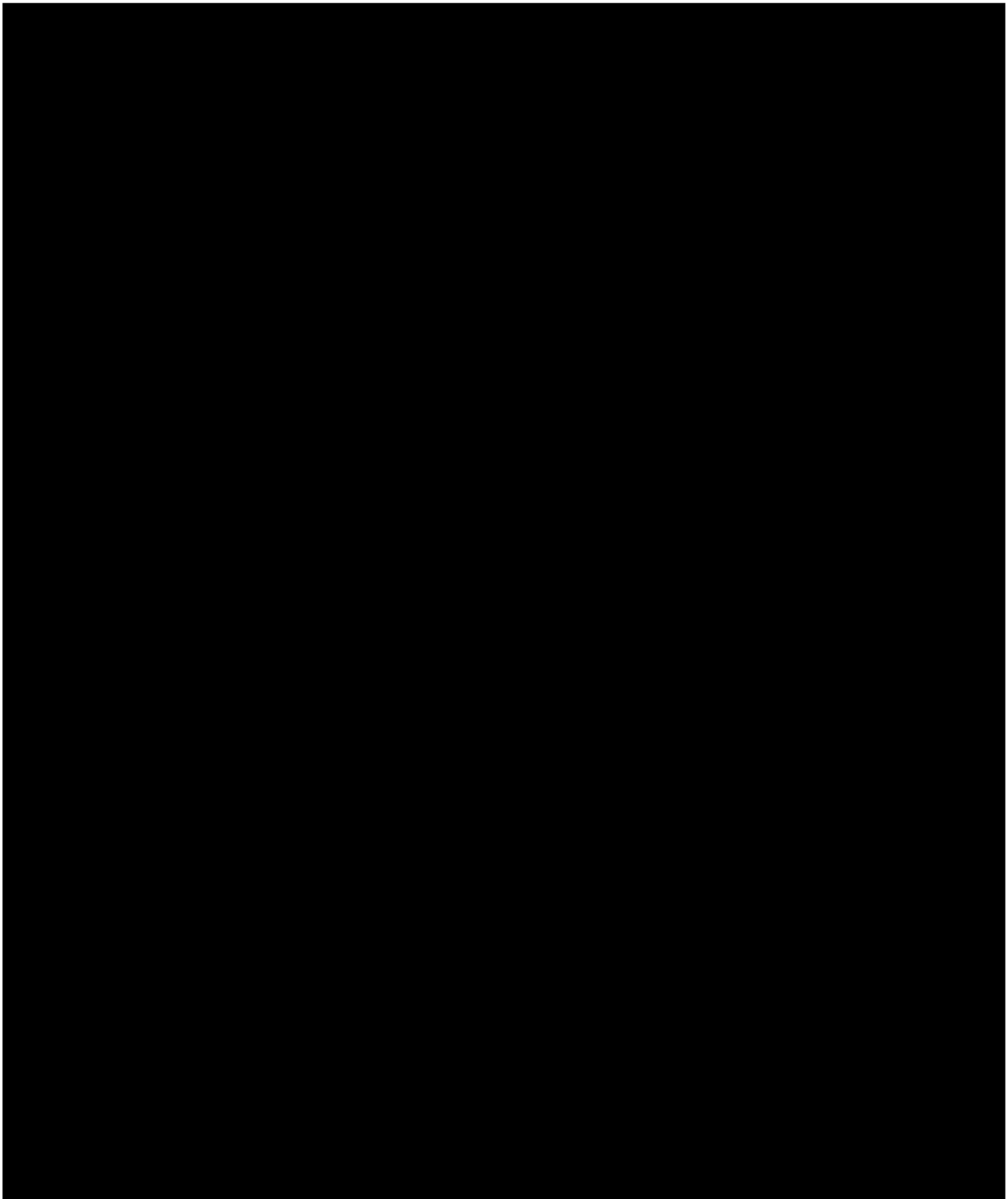

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of millirads rather than in terms of types of particles present and their energy spectrum. That is, the quantity measured by the Soviets is that which would be useful in determining the degree of danger to human beings. This is the same type of measurement that the Soviets have made in all of their manned Vostok and Voskhod flights. As a means of comparison, the announced rate of 30 millirads per day is about the same as the dose rate inside the Vostok capsules and is well within acceptable limits for human beings. [redacted]

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