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SURVEYOR III MISSION

Surveyor III landed on the moon's Ocean of Storms at 4:04:17 p.m. PST April 19, 1967, to achieve America's second successful soft-landing on the lunar surface.

Flight time for the National Aeronautics and Space Administration's Surveyor spacecraft was 64 hours and 59 minutes. The spacecraft was launched from Cape Kennedy, Florida by an Atlas-Centaur rocket combination.

Surveyor III was the first of the soft-landing series of spacecraft to carry, in addition to its television camera, a surface sampler device that dug, picked, scraped and trenched the lunar surface and moved small amounts of lunar material from one point to another.

First television picture transmitted to Earth by Surveyor III was received at the Goldstone, California station of the Deep Space Network less than 1 hour after landing. When night fell on the spacecraft's landing site on May 3, picture count totaled 6315.

Bulk of the pictures portrayed the lunar terrain. Others included portions of the spacecraft itself, surface sampler operations, an eclipse of the sun as seen from the moon, the crescent Earth, stars and the planet Venus.

Representative colors of the lunar surface, the eclipse and the Earth were derived from the pictures by alternating color filters in the camera and processing the filtered "black and white" pictures received on the ground.

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The surface sampler, a metal scoop deployed at the end of an extendable arm, was operated for a total of about 27 hours during the mission's first lunar day and left several dozen changes in the surface near the spacecraft: 4 trenches; 8 bearing strength imprints by driving the scoop in the surface; and 13 impact impressions by dropping the scoop from various heights.

Surveyor III lifted off from Cape Kennedy at 11:05:01 p.m. PST, April 16. The flight was the first operational mission for the Centaur second stage using the parking orbit launch technique in which the Centaur engines start and cut off twice, the second time after coasting in Earth orbit.

(Surveyors I and II in May-June and September, 1966, were launched by the direct ascent method in which the Centaur fires and cuts off only once.)

Surveyor III was injected into a highly accurate lunar transfer trajectory by the launch vehicle and would have encountered the moon, without midcourse correction, only 225 miles from the original aiming point. A minimum correction maneuver, requiring a firing time of only 4.28 seconds by the spacecraft's three vernier engines, was performed at 9:00 p.m. PST on April 17.

Terminal maneuver for the descent to the lunar surface began at 3:25 p.m. PST on April 19 by changing Surveyor's attitude to align its main retro engine with the approach direction. The 10,000-pound-thrust engine was ignited at 4:01 p.m. at an altitude of 52 miles and burned for 40 seconds, reducing the spacecraft velocity from 5900 mph to 313 mph at about six miles above the moon. The three vernier engines, firing simultaneously with the main engine, continued to slow the spacecraft to nearly zero mph a few feet above the surface.

Probably because of the very specular radar reflections received from the lunar surface during the final seconds before touchdown, the vernier engines did not cutoff at the prescribed 14-foot mark and continued firing to the surface.

The spacecraft touched down three times before coming to rest on the inner slope of a 650-foot-diameter crater. Strain gauge readings from Surveyor's three landing legs indicated that each of the three landings was as stable as the one perfect three-point landing of Surveyor I. A standard command transmitted from Earth to cutoff power to the propulsion system caused the engines to stop firing just a few feet above the surface prior to the final landing.

Pictures taken by Surveyor's TV camera during the next two weeks disclosed the footpad marks made by the spacecraft's landing feet on its second touchdown.

Following an engineering interrogation of the spacecraft to access its condition, the camera was commanded on and the first of 55 wide-angle, 200-line pictures was taken and transmitted to Earth. Later, during the initial Goldstone viewing period, commands to Surveyor aligned the solar panel with the sun and pointed the high-gain antenna toward the Earth, allowing transmission of higher resolution 600-line pictures.

Targeting point for Surveyor III was 3° South Latitude and 23° West Longitude, some 375 miles from Surveyor I's landing site in the western area of the Ocean of Storms. Selenographic coordinates of the actual location of Surveyor III are 2.94° South and 23.34° West as determined from tracking data and examination of Lunar Orbiter III photos and the Aeronautical Chart and Information Center (ACIC) map.

Comparison of surface features seen in both the Surveyor and Orbiter pictures has allowed scientist to pinpoint the landing site to within an accuracy of only a few feet.

Surveyor III landed on the moon approximately 20 hours after local sunrise, leaving 13 Earth days of operation in the sunlight. Pictures were taken on each day, with the exception of the sixth day after touchdown because of the normal rising temperatures at high noon.

On the morning of April 24, an eclipse occurred when the disc of the Earth passed between the sun and the moon. A lunar eclipse was observed from the Earth, hence a solar eclipse from the moon. Pictures were taken of the eclipse at various phases and of the lunar surface illuminated only by the subdued sunlight peeking out from behind the black disc of the Earth.

The eclipse also afforded the opportunity to conduct a series of thermal tests. During the eclipse, temperatures on the surface were estimated to have dropped from more than 200° F. to about 150° F. below zero.

Operation of the surface sampler was begun on the second day after touchdown. During ten Goldstone passes, 5879 sampler-directed commands were sent to the spacecraft, resulting in the generation of 1898 separate surface sampler movements.

In addition to digging the trenches and marking the surface with other tests, the sampler was used to pick up small rocks for close examination by the camera and to transport small amounts of lunar soil. One of the color pictures shows about two cubic inches of lunar material against the white top surface of Surveyor's footpad #2. The soil had been picked up in the sampler scoop and carried to the footpad.

Prior to sunset on the landing site on May 3, pictures were taken of the band of illuminated surface receding toward the eastern horizon. The Surveyor camera faced the eastern horizon - the inner rim of the crater in which the spacecraft landed two weeks earlier - as the sun sank directly behind the camera.

As night approached, darkness engulfed the spacecraft, then the wall of the crater until only the crater rim and a few blocks protruding above the rim were illuminated. From the shadow progression pictures, the orientation of the spacecraft and the television camera can be accurately determined.

Time of sunset was estimated to be 1:55 p.m. PDT, May 3.

In preparation for the two-week-long lunar night, the camera mirror was positioned downward to avoid the rising sun flashing into the camera. The surface sampler was left extended in view of the camera. The solar panel was positioned about 40 degrees off vertical - nearly edge-on to the eastern horizon - to prevent a sudden surge of power into the chilled electronics systems at sunrise.

All systems aboard Surveyor III were commanded off with the exception of the two radio receivers and the command decoder to allow possible reactivation of the spacecraft during the second lunar day. At sunset, capacity of the spacecraft battery was 140 ampere hours, thought to be sufficient to provide power for the receivers and decoder throughout the lunar night which ended with sunrise on May 17.

Attempts to reactivate Surveyor III began on May 23 and continued without success until sunset on June 1.