N1 the moon rocket that failed, part 1

By Barry Davidoff
Photo by Michel Koivísto and Staffan Skogby
Ericsson Astronomi Förening

The mammoth N-1 was created so that the first man on the moon would be a Soviet citizen. It was the Soviet Union's answer to America's Saturn V. The N-1 was the tallest rocket launched by the Soviet Union and it represented the finest in Soviet science and technology. There were four launches of the N-1. All four resulted in spectacular explosions within two minutes of launch hailing fire and debris over the Kazakstan desert.

Triumph and Tragedy

The flight of the N-1 in the photo below best represents the tragedy of the Soviet lunar landing program. It shows the second N-1 that was launched on July 3, 1969. Within seconds of launch it exploded in a fireball lighting the night sky for miles around. It destroyed not only its own launch pad but also the only other N-1 launch pad a half kilometer away. Less than two weeks later, on July 16, 1969 America launched the Saturn V carrying Apollo 11 triumphantly landing the first astronauts on the moon.

N-1 Exploding

Design of the N-1

The design of the N-1 began in 1960 as the rocket launcher to carry Soviet expeditions to the moon. The N-1 represented the best of Soviet technology as well as it limitations. The N-1 program like many parts of the Soviet program was veiled in secrecy. During the actual time period of the N-1 flights very little was known about the program and the only photos of the N-1 in the West were taken by American reconnaissance satellites. Following the American landing on the moon, the Soviet Union perpetuated the myth for several decades, that they never had a lunar landing program, and that their main goal in space only had been long duration orbital missions as in the Salyut and Mir programs. Only after the dissolution of the Soviet Union was the full story of the N-1 revealed. The Soviets, indeed had a highly developed plan for landing on the moon which vitally depended on the success of the N-1.

The N-1 had three stages and stood 105 meters tall weighing 2750 metric tons. Its first stage powered by 30 engines generated 4620 metric tons. On top of the first three stages of the N-1 was the L-3 lunar rocket assembly containing two additional stages that would be used to send the Lunar Orbiter Module (LOK) and the Lunar Lander (LK) on their way to the moon.

The N-1 had several distinctive design features which distinguish it from the Saturn V and most other rockets. The entire rocket has a Gothic appearance due to the large open truss grid work between the first stage and the second stage and the second stage and the third stage. The open truss work allowed an upper stage to ignite prior to the jettison of the lower stage. The large diameter of each stage was required since the stages contained large spherical tanks carrying liquid oxygen and kerosene that were not integral with the walls of the stage. Separate spherical tanks were needed due to a limitation of Soviet manufacturing technology which did not allow the fabrication of aluminum that was more than 27 millimeters thick. In the Saturn V the actual walls of the stage formed the tanks and the propellant and oxidizer were separated by domed bulkheads within the stage.

Thirty Engines for the First Stage

The greatest problem for the N-1 was the engine design. The roots of this engine problem had its origin in the Soviet gulags and the bitter rivalry between different design bureaus. The N-1 was created by design bureau headed by Sergei Korolev (1907- 1966). Korolev and his bureau had been responsible for the early Soviet successes in space. His achievements included Sputnik, (the first orbiting satellite), Luna 2 (the first earth ob-

ject to hard land on the moon), Venera 1(the first space probe to reach Venus) and Vostok (the first man in space, Yuri Gagarin). During his lifetime Korolev was known only by his title of Chief Designer and was a protégé of Soviet Premier, Nikita Khruschev.

The design of Soviet rocket engines, however, was the responsibility of another bureau headed by Valentin Glushko, who was an arch rival of Korolev. Glushko was opposed to the development of very large rocket engines or the use of liquid hydrogen as a propellant. As a result Soviet rocket engine design was many years behind the American progress, which developed the powerful J-1 engine using liquid hydrogen for the second and third stages of the Saturn V. Glushko did not believe in the N-1 program and that his bureau would be better served by continuing development of engines for the military including ICBMs. When the N-1 was first proposed by Korolev as the moon rocket, Glushko and his bureau refused to participate. The design of the engines therefore was given to another bureau headed by Nikolai Kuznetsov.

Kuznetsov's bureau was handicapped from the start by Glushko's predilections and lack of progress. It would be impossible to design very large engines for the first stage or a liquid hydrogen powered engine for the upper stages in order for the N-1 to beat the Saturn V. The engine that Kuznetsov's bureau could design and produce generated only 153 metric tons of thrust.

The solution was to use thirty NK-15 engines which were ignited simultaneously to power the first stage. This solution was N-1's fatal flaw that were not integral with the walls of the The difficulty of having thirty rocket engines, each with hundreds of parts work in perfect harmony was enormous, especially using the very limited computerized control technology that was available in Russia in the 1960's. All four N-1's exploded shortly after launch due to engine and control system failures.

Korolev himself did not live to see the actual flights in the N-1 program. He died in January 1966 and his successor was Vladamir Mishin who lacked the charisma and leadership ability of Korolev. All the N-1 flights occurred with Mishin being in charge of the design bureau.

The N-1 Stages

The N-1 was designed as a three stage rocket for lunar missions. The three stages would launch the 95 metric ton L-3 lunar rocket assembly into earth orbit. The L-3 consisted of two additional stages, Blocks G and D along with the lunar orbiting module, (*Lunny Orbital'ny Korabl'* or LOK) and the lunar lander (*Lunny Korabl'* or LK). The LOK would carry two cosmonauts the moon, but only one would land in the LK.

Specifications *Total Length* **105 meters;** *Core Diameter Maximum* **16.9 meters;** *Weight* **2750 metric tons;** *Thrust at Lift-off* **4420 tons;** *Payload into Low Earth 0rbit (225 km.)* **95 metric tons**

First Stage- *Length* **30.1 meters;** *Diameter (max./min.)* **16.9 meters /10.3 meters ;** *Total Weight* **1880 metric tons;** *Empty Weight* **130 metric tons;** *Weight of Propellant* **1750 metric tons;** *Propellants* **Kerosene and Liquid Oxygen;** *Number of Engines* **30 NK-15**

Second Stage- *Length* **20.5 meters;** *Diameter (max./min.)* **9.8 meters /6.8 meters;** *Total Weight* **561 metric tons;** *Empty Weight* **56 metric tons;** *Weight of Propellant* **505 metric tons;** *Propellants* **Kerosene and Liquid Oxygen;** *Number of Engines* **8 NK-15V**

Third Stage- *Length* **14.1 meters;** *Diameter (max./min.)* **6.4 meters /4.8 meters;** *Total Weight* **189 metric tons;** *Empty Weight* **14 metric tons;** *Weight of Propellant* **175 metric tons;** *Propellants* **Kerosene and Liquid Oxygen;** *Number of Engines* **4 NK-21**

Block G- *Length* **9.1 meters;** *Diameter* **4.4 meters;** *Total Weight* **62 metric tons;** *Empty Weight* **6 metric tons;** *Weight of Propellant* **56 metric tons;** *Propellants* **Kerosene and Liquid Oxygen;** *Number of Engines* **1 NK-19**

Block D- *Length* **5.7 meters;** *Diameter* **2.9 meters;** *Total Weight* **18.2 metric tons;** *Empty Weight* **3.5 metric tons;** *Weight of Propellant* **14.7 metric tons;** *Propellants* **Kerosene and Liquid Oxygen;** *Number of Engines* **1 RD-58**

N-1 Mission

The N-1 was designed primarily as a rocket to reach the moon. After considerable debate and following the lead of the Apollo program, the Soviets adopted a Lunar Orbital Rendezvous (LOR) method of landing on the moon. The entire Soviet lunar landing program was greatly limited by the inherent inefficiency of the N-1 design and its limited payload. Only two cosmonauts could be carried into lunar orbit and only one cosmonaut would descend to the surface. The mission profile was much more complex than Apollo. It placed enormous strain on the mission commander who would have to perform alone two space walks and a moon walk as part of the mission.

The first three stages of the N-1 would launch the L3 lunar rocket assembly into earth orbit. The L3 consisted of two additional stages, Blocks G and D along with the lunar orbiting module, (*Lunny Orbital'ny Korabl'* or LOK) and the lunar lander (*Lunny Korabl'* or LK). The LOK was, after orbiting the earth, Block G would be used to boost the combined LOK and LK assembly on a trajectory towards the moon. Block G would be jettisoned after making this trans-lunar injection (TLI) burn. After a several day journey to the moon the large engine in the Block D would fire and the combined LOK and LK would go into lunar orbit.
While orbiting the moon the mission commander would leave the LOK and make a space walk to enter the LK. A space walk was required since an internal connection between the LOK and LK had not been included to save weight. After the commander entered the LK he would fire the engine on Block D, to begin his solo descent to the moon. About three kilometers above the surface, Block D would be jettisoned and the descent engine of the LK would be used for the landing on the moon. The unoccupied Block D would crash into moon a few kilometers away from the LK.

Once on the moon the commander's work was lonely and extremely arduous.The commander would climb down the LK ladder and by himself explore the lunar surface for several hours. The commander's *Kretchet* space suit had been designed with a hula hoop like ring around it so that in the event that the commander fell during his solo moon walk he would be able to turn over by himself and get up.

Photo of LK

At the end of his moon walk the commander would re-enter the LK and prepare for returning to the LOK. The ascent stage of the LK would lift-off, leaving the descent stage of the LK behind on the moon. The ascent stage would rendezvous with the LOK. Following rendezvous the commander would then make another perilous space walk to re-enter the LOK. The LK would be separated from the LOK and the LOK's propulsion unit fired to return to earth. On the final portion of the re-entry trajectory the descent module of the LOK carrying the two cosmonauts would be separated and only the descent module would make a soft landing in Kazakstan. Unlike Apollo the recovery of the descent module would be on land due to the greater land mass of the Soviet Union.

The cosmonaut that was most likely to be the commander of the first lunar landing mission was Alexi Leonov, who had made the world's first spacewalk. The entire moon program was extremely hazardous due to its complex nature and that the commander would have to perform many tasks alone in order for the mission to be successful. Leonov once remarked that the chance of the first mission returning safely was only 50-50, but that this risk was acceptable to him.

Prelude to the First N-1 Launch

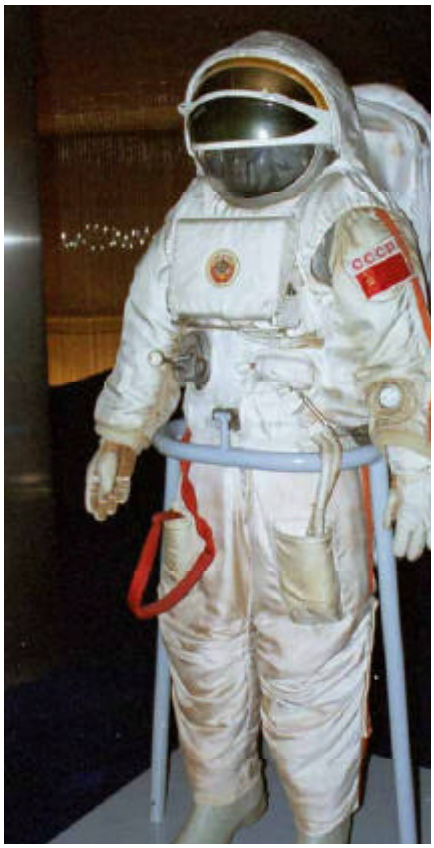
As the first launch of the N-1 was approaching competition in the space race was intense. In 1967 both sides had suffered tragedies with the American Apollo 1 fire and the Soviet loss of Vladimir Komarov in the crash of Soyuz 1 on its first manned mission. On October 11, 1968 Apollo 7 was launched on an eleven day mission in a highly successful first manned test of the Apollo capsule. Just four days after Apollo 7 landed, the Soviets launched Soyuz 3. Although Soyuz 3 did not dock with the unmanned Soyuz 2, it did rendezvous within 200 meters which demonstrated the functionality of Soyuz.

In September 1968 the Soviets also launched the unmanned Zond 5 on a circum-lunar flight which passed within 2000 kilometers of the moon. Zond 5 was similar to the LK lunar orbital module and although it landed with a force between 10-15g, the capsule was recovered in the Indian Ocean. In November the Soviets launched Zond 6 which also circled the moon. Zond 6 used a different reentry trajectory in which it skipped through the atmosphere prior to landing. Since little official information was released it appeared that the next step for the Soviets would a manned circum-lunar flight.

The first N-1, an engineering prototype had been rolled out to the Balkinour launch pad as early as November 25, 1967. The existence of the Soviet moon rocket was confirmed with photos taken American reconnaissance satellites just a few days later. A second N-1 was rolled to the launch pad in May 1968 in preparation of an October launch. This N-1 developed hairline cracks in one of its liquid oxygen tanks causing a significant postponement in the N-1 program.

The second N-1 had profound effects on the race to the moon however. Reconnaissance photos of the second N-1 demonstrated that the launch of one of these giant rockets was imminent. As a result during the summer of 1968, NASA accelerated the Apollo program and determined that the Apollo 8 mission would be to orbit the moon in December, rather than just another test of the Apollo command module in higher earth orbit. By Christmas Eve, the Americans took a commanding lead in the space race when three astronauts aboard Apollo 8 orbited the moon.

The last year of the decade began with the expectation that the United States would be successful in landing a man on the moon with Apollo 11 in July. The Soviets continued in their efforts, however, and in January 1969 Soyuz 4 and 5 docked in orbit. Two crew members aboard Soyuz 5 made a spacewalk and returned to earth aboard Soyuz 4. It was the first time that two manned spacecraft had rendezvoused in space, which was an essential task in the lunar landing program. Even as Apollo 8 was orbiting the moon, the first N-1 to be launched, L-3, was rolled out at Balkinour. In late February 1969, all the stages were set for the launch of the first N-1.



Kretchet space suit

Part 2 of this article will follow in the next issue of EAF-Nytt.