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Chapter 10

The Development of the Booster-Launchers in the U.S.S.R.*

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Soviet space and rocketry technology started with the first man-made satellite launch using an intercontinental ballistic missile (ICBM) on October 4th 1957.

This ICBM program development was an urgent need for the U.S.S.R. in the early fifties. The U.S.S.R. was surrounded by an American, and its allies', air force base network, and all the Soviet administrative and industrial centers were vulnerable to possible strikes. The sole possibility of obtaining parity was to create a vehicle capable of reaching U.S. territory. This goal could be met by using an ICBM that was technically feasible in those times.

The creation of a booster-launcher capable of placing 5 tons of payload into orbit was necessary to meet the goal of the transportation of a heavy nuclear warhead tested in the U.S.S.R. This rocket could put a heavy (1.5 ton) Earth satellite into orbit. The development work on this satellite project started with the beginning of ICBM creation work.

In those days, the U.S. started an advertisement campaign that the American satellite made for the "Vanguard" program would be launched during the

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International Geophysical Year. S. P. Korolev made the proposal to launch a Simple Satellite (SS) as part of an ICBM test program, and he submitted the proposal to the government. The proposal had governmental support. After the first successful ICBM test, the first Soviet 86-kg satellite was put into near-Earth orbit.

The satellite manifested the beginning of the space era in the Soviet Union. On November 4th 1957, the second Soviet satellite (SS-2) was put into orbit. The satellite weighed 508.3 kg and had the dog Laika inside. A heavy (1,327 kg) laboratory-satellite with 958 kg of scientific equipment was launched in May 1958. Development of the satellite started simultaneously with the R7 ICBM development work. The launching of the scientific high-altitude rockets, created on the first Soviet ICBM basis, paved the way for the first Soviet satellite launchings.

The next step in Soviet space and rocket technology development was the creation of the three-stage booster-launcher (on an R7 ICBM basis), with the "E" rocket unit as the third stage. The three-stage booster-launcher was the primary tool for various Earth satellites, piloted Vostok spaceships and the first inter-planetary Moon, Venus and Mars stations launches.

The booster-launcher was later nicknamed "Vostok" after the Vostok spaceships launched with it. On April 12th 1961, Soviet cosmonaut, Y. A. Gagarin, orbited the Earth in 108 minutes in a Vostok piloted spaceship (PSS), which was put into orbit by this booster-launcher. A lot of ground-based and flying tests of parts and systems of the booster-launcher were performed before the first manned spaceflight. Automated analogous-spaceships had been orbited and returned to the Earth.

The next step in Soviet space and rocket technology development concerned the creation of the four-stage booster-launcher (on the R7 ICBM basis), with the "I" rocket unit as the third stage and the "L" rocket unit as the fourth stage. This booster-launcher made it possible to send the second generation heavy automated spacecrafts to the closest planets. It was connected with the possibility to start the "I" rocket unit engine in orbit at the set time after an inertial flight in weightlessness. The booster-launcher was later nicknamed "Molnya" after the Molnya telecommunication satellite put into near-Earth orbit with it.

The "I" rocket unit with the RO-9 engine, developed by the design bureau headed by S. A. Kosberg, was tested during the second generation ICBM tests. Beginning in 1962, light satellites for various missions were orbited not only by booster-launchers made on the R7 ICBM basis but also by booster-launchers made on the basis of ICBMs scrapped from the military service. This was the two-stage Kosmos booster-launcher developed on the basis of the intermediate range ICBMs, which were the two-stage Tsiclon ICBM's in use since 1966, and the three-stage modification of this rocket in use since 1977. Both were developed on a second-generation ICBM basis.

The next step in Soviet space and rocket technology development was connected with the creation of the three-stage rocket (on the R7 ICBM basis) with the "I" rocket unit from the Molnya booster-launcher. The booster-launcher was used for Voskhod-series spaceship launchings, and it is still in use for Soyuz-series spaceships and Progress-series cargo spaceship launchings.

From the beginning the Soyuz-series spaceships were being created for two spaceships to achieve an orbital docking and for cosmonauts to change spaceships via space. Later on, spaceships of the series were redesigned, and cosmonauts were able to move through the hatch into the Salyut-series orbital stations, and into an American Apollo spaceship during the "Soyuz-Apollo" Soviet-American program.

In 1971, the "Salyut" orbital station visited by Soyuz spaceships was developed. Work was started after termination of the UR500K-L1 program for sending a crew of two to orbit the Moon and Return to Earth with escape velocity.

Several automated spacecrafts of the Zond-series were launched during the program. Four vehicles - Zond-5, 6, 7, 8, - in 7K-L1 manned spaceship configuration orbited the Moon and returned to the Earth successfully. Unfortunately the manned spaceflights of 7K-L1 spaceships were not performed, because the U.S. had success in orbiting the Moon in the Apollo-8 spaceship with three astronauts on board due to the "Saturn 5 - Apollo" program.

The Salyut orbital station was developed on the basis of the Almaz orbital station shell structure designed by the design bureau headed by V. N. Chelomey, and Soyuz spaceship service systems and scientific instrumentation were developed by the U.S.S.R. Academy of Science and research institutes. An Almaz-series orbital station (similar to the American Work Shop) was being developed with a three-stage UR800K (later dubbed "Buran") booster-launcher in mind. This booster-launcher used the "D" rocket unit developed due to the "Saturn 5 - Apollo" program, which had been well-supported in financial and organizational terms, and which thus influenced the Soviet program greatly.

The work process start delay and race atmosphere affected the quality of the development work. From the very beginning, the N1-L3 Soviet Moon Program characteristics were known to be worse than the "Saturn 5 - Apollo" American ones. It concerned using liquid hydrogen/liquid oxygen as a rocket fuel. Thus, a crew of three could be sent to the Moon by the "Saturn 5 - Apollo," and only two cosmonauts could be sent by the Soviet N1-L3, with the weight of the vehicles being practically equal.

Four launches of the N1-L3 booster-launcher with the lunar spaceship mock-up were performed in the Soviet Union from 1969 until November 1972. All the launches were unsuccessful due to "A" first stage rocket unit malfunctions. The fourth launch was performed in November 1972. It was the most successful launch, but unfortunately it was aborted due to first stage malfunction. At the 107th second of flight time, during the first-stage rocket engine regime changing, a fire began and the rocket crashed. Origins of the fire were not determined. The most likely cause was rocket unit construction element destruction due to high dynamical loads during the engine regime changing. Some work was done to diminish the loads, and the cyclogramm of the "A" rocket unit engine regime was changed.

The U.S.A. won the Space Race. They orbited the Moon with the "Apollo-10" spaceship. Two American astronauts—Armstrong and Aldrin—were the first to visit the Moon, and they returned safely with the "Apollo-11" spaceship. From 1969 until 1972, six successful American expeditions to the Moon were performed. Twelve American astronauts visited the Moon. After that the Soviet government lost interest in lunar expeditions and all work was terminated, although a lot of problems had been solved. This decision was a mistake, as it was proved later, because for more than fifteen years we had no heavy booster-launcher, and we had no means to perform a lunar expedition on a more elaborate scenario than the "Saturn 5 - Apollo" one.

After N1-L3 program termination, work on the "Salyut" and "Almaz" orbital station was continued. Until 1975, this work was arranged in parallel ways. The "Almaz"-series OSs launchings (with "Soyuz"-series spaceships as visiting flights) were dubbed the "Salyut-3" and -4 missions, and the "Salyut"-series launchings were dubbed "Salyut-1, -2, -5" missions. [Editor's note: The Almaz series actually were designated Salyut 2, 4, & 5.] "Salyut-6" and "Salyut-7" were second-generation OSs with two docking ports. In 1986, the modular "Mir" OS was put into orbit. The orbital station was designed on the "Salyut" basis, was put into orbit by a modified "Proton" booster-launcher, and was to be visited by "Soyuz TM" spaceships orbited by the Soyuz booster-launcher. The Salyut-6, Salyut-7 and "Mir" OSs were the principal means for the most prolonged missions and for the international spaceflights.

Late in 1971, the lunar landing mission program was developed. The program provided two N1 rocket launches with the various parts of the lunar complex to be assembled in lunar orbit. The first launch was to put the "D2" deceleration rocket unit into near-Moon orbit. After successful "D2" rocket unit orbiting, the lunar space module was launched, consisting of a landing capsule with a crew of three, a lunar landing craft and a rocket unit to be put into near-Moon orbit. The "D2" rocket unit was to dock with the lunar space module in this orbit. The landing capsule had the opportunity to return to the Earth with the crew in case of an aborted docking.

After near-Moon docking, the lunar space module was to decelerate by use of the "D2" rocket unit, and the final deceleration, maneuvers and landing were to be performed by using the "Em" rocket unit. The landing capsule take-off from the lunar surface and acceleration to the escape velocity was to be performed by the "Em" rocket unit. This unit was to be separated from the capsule after entering the atmosphere. The scheme of air braking and parachute-use descending was similar to the SS 7K-L1 scheme. It was proved many times during the automated version of 7K-L1 - "Zond" -decelerations and landings.

The N1-L3M was an updated variant of the N1-L3 program. It made it possible to put three cosmonauts on any point of the lunar surface, with the working time limit being 14 days and the possibility of stretching the limit up to 30 days. The cosmonauts were able to return to the Earth at any moment. Unfortunately, the development work on the mission was limited to the draft projects only. Early in 1972, the detailed project was approved by the General Designers Board, but then the project was laid aside and all work terminated.

By 1976, the rocket engines used for the first "A" stage of N1 had such a reliability level, that they worked on a test site for 12,000 sec with the total flight time being 140 sec.

In 1969, before the "Saturn 5 - Apollo" program cancellation, work on the Space Shuttle started in the U.S.A. The main goal of the new program was to create a transport vehicle with the possibility of reducing the cost of payload orbiting more than ten times in comparison to rockets. The first flight of the Space Shuttle was performed in 1981, and 47 missions were completed in due course, despite the *Challenger* crash in January 1986.

The development work on the analogous Soviet "Energia-Buran" system started in 1974, after the "N1-L3" program cancellation and five years after the American program started. The first "Energia," with a payload mockup, launch took place May 15th 1987, and "Energia," with the unmanned "Buran," on November 15th 1988. The planned "Energia-Buran" launches depend heavily on funding because of the economical crisis in this country.

The complex was created with the N1-L3 program experience in mind, especially in the ground starting complex. A number of new scientific and technical problems were solved during the complex development, especially on the "Buran" vehicle.

The "Energia-Buran" complex differs from the Space Shuttle:

1. It has four side-attached rocket units with liquid-fueled rocked engines, instead of two solid-fueled boosters.
2. The main rocket engines are in the central unit, instead of in the orbital vehicle.
3. The complex has two guidance systems in an orbital vehicle and in a central unit, instead of a single system in the orbital vehicle only
4. The complex can work in piloted and automated modes, instead of in a piloted one only.

Engines in the central unit, a guidance system working in an active phase of trajectory, made it possible to convert the central unit, with four side-attached boosters, into the "Energia" booster-launcher, capable of putting up to 100 tons into near-Earth orbit.

In 1985, the "Yuzhnoe" design bureau (the first head of which was M. K. Yangel) created the "Zenith" booster-launcher on the basis of the "Energia" side-attached booster with the RD-170 rocket engine. It is a two-stage rocket with side-by-side separation. The first stage is a converted "Energia" side booster. The second stage has an RD-120 rocket engine with 834 kN thrust and a specific impulse of 343.9 sec, and it can put 13.74 tons of payload into a 51.6-degree orbit, and 11.38 tons of payload into a 99-degree orbit. Up to the present time, 16 launches of the rocket have been executed. Unfortunately, three of them were unsuccessful. Nevertheless, the rocket could be used extensively, due to good characteristics of the whole complex. After some updating, the first stage could be reusable after launches in any direction. In this case, the rocket could be omniazimuthal, diminishing the launch costs in comparison with the existing rockets.

The promised substantial cost reduction, due to using the Space Shuttle, appears to be faulty. The costs appeared to be the same as in the case of existing rockets. The cost of payload orbiting by "Energia" would be no less than that for the existing rockets. Therefore, further space explorations by the U.S.S.R. and U.S.A. depend on new transport vehicles, which make it possible to diminish the costs of putting payloads into near-Earth orbits.