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Chapter 8

The Conquest of the Moon 1958-1969: The Race Between the Soviet Union and the United States of America*

Jacques Villain[†]

We shall send to the moon, 240,000 miles away from the control station in Houston, a giant rocket more than 300 feet tall, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food and survival, on an untried mission, to an unknown celestial body. [...] We choose to go to the moon in this decade and do other things, not because they are easy, but because they are hard.

John F. Kennedy
September 12, 1962
Rice University, Houston

* Presented at the Thirty-Second History Symposium of the International Academy of Astronautics, Melbourne, Australia, 1998. Copyright ©1998. Published by the American Astronautical Society with permission.

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Space: A Cold War Challenge

The Cold War between the United States and the Soviet Union raged from 1945 until 1991. The two champions of opposing political systems each sought to eclipse the other without risking an all-out military confrontation. The “Space Race” served as a proxy war, allowing both superpowers to flex their technological, ideological and political muscle without the physical risk of an armed conflict.

This space war actually comprised a number of battles, beginning in 1957 with Sputnik and finishing in the late 1980s with the Soviet shuttle Buran. Throughout the period, and more particularly between 1958 and 1969, the Moon was the main focus of the space race. This phase reached its climax with the first man on the Moon in 1969.

1945 -1955: On Your Marks...

In the early stages of the Cold War, the United States and the Soviet Union prepared for the Space Race against a backdrop of political and technological rivalry. Already by 1944-45, the two nations were competing for Germany’s V2 rocket know-how and the scientists who designed it. Even at this early stage of the game, the race was already on to build up an arsenal of ballistic missiles and nuclear warheads. From 1953-54, the question was: who would be the first to build an intercontinental missile capable of reaching the opponent’s territory? This was also a crucial step in the development of the rocket launchers which would usher in the space era. As orbital launches began to seem possible, the two superpowers began to consider what the role of satellites might be. Some initial studies were commissioned, but there was little follow-up.

July 29, 1955: the Space Race Gets Under Way

As the Americans and Soviets built up their nuclear arsenals, the International Council of Scientific Nations, meeting in Rome in 1951, adopted a resolution aiming at the launch of an artificial satellite during the International Geophysical Year (July 1, 1957 to December 31, 1958). Only the Soviet Union and the United States took on this challenge.

On May 26, 1955, the National Security Council of the United States approved a satellite project, and on July 29, President Eisenhower officially announced the United States’ intention to launch a satellite. However, six months earlier, in January, Radio Moscow had announced a similar plan.

So it was only in mid-1955 that the U.S.-Soviet space race really got under way, as tension between the two superpowers gradually increased. In August, during the International Astronautical Congress in Copenhagen, Leonid Sedov, spokesman for the Soviet delegation and head of the Interplanetary Studies Commission of the Academy of Sciences, announced quite simply that *"The Soviets will be the first to launch a satellite, and it will be bigger than the Americans'."* Since the Americans were planning to loft their satellite with the Vanguard rocket in December 1957, one could only imagine that the Soviets were aiming for autumn of the same year, possibly even September 17, the centenary of the birth of Tsiolkovski, the great Russian astronautics pioneer. This was in fact what Sedov seemed to confirm when he declared that the Soviets aimed to celebrate the centenary in *"the most spectacular way imaginable."* It later emerged that this was indeed the target date, but problems with the preparation of the Semioroka rocket had caused the launch to be postponed. In June 1957, four months before the launch of Sputnik-1, the United States began to have a clearer idea of what its adversary was up to. CIA Director Allen Dulles declared that *"the U.S. intelligence community is of the opinion that, for psychological reasons of prestige, the USSR will make every effort to be the first to launch a satellite... probably in 1957."*

At the Copenhagen congress in 1955, an American representative asked Sedov whether *"the first man in space will be Russian or American,"* to which Sedov replied with a slight smile: *"Neither one nor the other. The first astronaut will be a dog: a Russian dog of course!"*

October 4, 1957: The Soviets Win the Satellite Race

The Soviets scored their first Space Race victories in 1957, successfully launching their first intercontinental missile on August 21 and the Sputnik-1 satellite on October 4.

Their success caused a huge stir across the world: the Soviet Union had gained a major psychological and technological edge over the West. Outside the Soviet Union, and in particular in the United States, there was total surprise: no one had expected the Soviets to launch a satellite so soon. Forty years later, the American reactions seem a little excessive, and yet they certainly reflected the climate of the period. For example, Dr. Joseph Kaplan, chairman of the U.S. commission of the International Geophysical Year, said that *"if the Soviets can launch an 83 kg satellite, that means they can also launch a much heavier one."* American scientists wondered whether the satellite had been launched by the intercontinental rocket the Soviets had recently developed. *The New York Herald*

Tribune saw the event as “a major defeat for the United States.” While Defense Secretary Charles Wilson had made ironic comments about the Soviets’ intercontinental rocket, his successor, Mr. McElroy, stated that “we now have to take the Russians seriously.”

Nonetheless, some Americans did treat the event as something of a joke. One Pentagon official even went as far as saying that the satellite had been “nothing more than a lump of scrap iron anyone could have launched.” But the notion that the satellite represented a threat to U.S. interests had already taken root. There were suggestions that a hydrogen bomb could be launched over New York or Washington, leaving Americans with only 15 minutes to riposte. That didn’t mean that the Russians were the new masters of the world, of course, but they were now at least on an equal footing with the Americans, and technologically ahead in the Space Race.

The Cold War was by now in full swing, and the Soviets used Sputnik to try and gain a diplomatic advantage. Andrei Gromyko, the Soviet Minister of Foreign Affairs, asked to meet with the American Secretary of State, John Foster Dulles, only hours after the launch. During the three-hour meeting, Gromyko reportedly said to Dulles: “Mr. Secretary, your intelligence services have perhaps already notified you that Soviet scientists launched the first artificial satellite this afternoon.”

The “Space Race” between the Americans and the Soviets was now a reality. For the United States, the Sputnik launch seemed like a second Pearl Harbor, only this time it was a political, technological and PR defeat rather than a military one. And the Americans’ counterattack would be just as spectacular as their victory over the Japanese in the Pacific.

The Americans Save Face

The first American satellite, Explorer-1, was launched on January 31, 1958. The Americans had regained some of their honor, but swore they would never again find themselves lagging behind in the Space Race. What they didn’t yet realize was that the Soviets’ lead was even greater than they had imagined. The road to space supremacy would be a long one and the Americans would just have to live with the current success of their adversaries, especially since Khrushchev intended to pull out all stops to ensure Soviet supremacy in space. One thing was certain: the race was on and the Soviets were way out in front.

Until 1965, the Soviets Win Every Race (Probes Excluded)

The Soviet Union rapidly built on the success of Sputnik-1. Soviet propaganda demanded that their engineers constantly come up with new successes to raise the profile of the USSR and Communist ideology across the world. This led to an initial wave of spectacular space firsts, bolstering the Soviet Union's image as a technologically dominant country.

Year	Achievement	Spacecraft
1957	First animal in space (the dog Laika)	Sputnik-2
1958	First scientific satellite	Sputnik-3
1959	First object to escape Earth orbit	Luna-1
1961	First man in space (Yuri Gagarin)	Vostok-1
1962	First dual flight in space	Vostok-3 and 4
1963	First woman in space (Valentina Tereshkova)	Vostok-6
1964	First three-man crew in space	Voskhod-1
1965	First spacewalk (Alexei Leonov)	Voskhod-2
1967	First impact on Venus	Venera-4

Nevertheless, the Americans realized two major achievements:

1962	First probe to fly by Venus (34,632 km)	Mariner-2
1958	First probe to fly by Mars (9,780 km) and transmission of the first pictures of this planet	Mariner-4

The United States Ahead in Commercial and Military Applications

The United States, although aware of how space exploits could enhance a country's image, made strong headway in practical space applications in the period 1961-1965:

Year	Achievement	Spacecraft
1958	First telecommunications satellite (prerecorded Xmas message from President Eisenhower)	SCORE
1959	First television images transmitted	Explorer-6
1959	First polar orbit satellite, first reconnaissance satellite	Discoverer-1
1960	Distance record for radio link in solar system	Pioneer-5
1960	First weather satellite	Tiros-1

1960	First active telecommunications satellite (military)	Courier-1B
1960	First navigational satellite	Transit-1B
1960	First successful recovery of a capsule	Discoverer-13
1960	First passive telecommunications satellite	Echo-1
1960	First in-flight recovery of a capsule	Discoverer-14
1963	First geostationary satellite	Syncom-2

1958 -1968: The Soviets Win the Lunar Probe Race

In the months following the Sputnik-1 and Explorer-1 launches, the Moon developed into a primary goal for both the Soviets and the Americans. The dream of interplanetary travel could at last be realized and the two superpowers entered a new phase of the Space Race. The United States was the first off the mark, with a lunar probe launch on August 17, 1958. But it failed, as did a Soviet attempt on September 23 of the same year. Initially, these lunar impact missions were simply a question of national prestige. The American Pioneer and Ranger probes and the first Soviet Luna probes, launched between 1958 and 1965, fell into this category. It was only with the American Lunar Orbiter satellites and the Soviet Luna-10 to 14 probes, launched from 1966 to 1968, that scientific missions found their way onto the agenda. At the same time, both countries were experimenting with soft-landing missions, for example the American Surveyor probes and the Soviet Luna-9.

Between 1958 and 1968, the USSR and the United States sent a total of 60 probes around or to the Moon:

	USSR	United States
Number of probes launched	31	29
Success rate	29%	45%
Failures due to launchers	63%	77%
Time from program start to first Moon impact	1 year	4 years
Number of attempts before 1st Moon landing	10	None (success on the 1 st attempt)

However, as the chart below indicates, the Soviet Union achieved all the major breakthroughs in lunar probe missions.

ACHIEVEMENT	DATE		
	Soviet Union	United States	U.S. lag
First Moon probe launch	Sept. 23, 1958	Aug. 17, 1958	U.S. 37 days in advance
First launch of probe near the Moon	Jan. 4, 1959 (Luna-I)	Mar. 5, 1959 (Pioneer-4)	2 months
First Moon probe landing	Sept. 14, 1959 (Luna-II)	Apr. 26, 1962 (Ranger-4)	31 months
First photo of dark side of Moon	Oct. 7, 1959 (Luna-III)	Aug. 1966 (Lunar Orbiter-1)	70 months
First soft landing	Feb. 3, 1966 (Luna-IX)	June 2, 1966 (Surveyor-1)	4 months
First Moon satellite	Apr. 3, 1966 (Luna-X)	Aug. 12, 1966 (Lunar Orbiter-1)	4 months
First soil data	Apr. 3, 1966 (Luna-)	Apr. 19 1967 (Surveyor-3)	12 months

The Final Showdown: A Man on the Moon

General Mobilization in the U.S.

A heavy launcher was needed to put a man on the Moon. The U.S. Army Ballistic Missile Agency (ABMA) and Wernher von Braun started planning for such launchers as early as 1958. High-thrust engines (over 600 metric tons) and liquid hydrogen engines were also under consideration. This early work was to play a decisive role in the later U.S. success. By the end of 1959, NASA proposed a manned circumlunar flight before 1970 for a cost of 26 to 38 billion dollars. However, President Eisenhower rejected the proposal.

Nor was his successor, John F. Kennedy, very enthusiastic about the costs involved. Kennedy suggested to the USSR that they cooperate on the project, but his proposal fell on deaf ears. Two critical events would change his mind: firstly the flight of Yuri Gagarin on April 12, 1961, and a short time later the Bay of Pigs fiasco, the disastrous attempt to invade Cuba, which tarnished the United States' image.

On May 25, 1961, encouraged by Vice-President Lyndon B. Johnson, Kennedy declared before Congress and the entire world that: *"... this nation should commit itself to achieving the goal, before the decade is out, of landing a man on the moon and returning him safely to the Earth."*

It was a remarkable ambition considering that, at that time, the Americans had yet to even put a man into orbit. There were a number of technological challenges to

be met, including the development of the Saturn V launcher, the largest ever built, and the intermediary versions, Saturn I and IB. Propulsion and inertial guidance systems also constituted major challenges, requiring entirely new quality assurance and reliability procedures.

Another major problem was deciding how to reach the Moon, using either a lunar or Earth orbit rendezvous. It wasn't until 1962 that a decision in favor of a lunar orbit was made.

In short, the United States had to mobilize all its resources. The cost of the Saturn/Apollo program was estimated at \$25 billion (equivalent to \$120 billion today). NASA's budget increased from \$500 million in 1960 to \$5.2 billion in 1965, or 5.3% of the Federal budget. NASA staff numbers also rose exponentially, from 10,000 in 1960 to 36,000 in 1966. Over the same period, the workforce of the U.S. space industry increased tenfold, from 36,500 to 376,000. Over 20,000 U.S. and foreign firms from 80 countries worked on the Apollo program. Production of gyroscopes and accelerometers for the guidance system alone required 2,000 people! Some 200 universities were also involved in the Moon effort.

Almost 10 million people are estimated to have been directly or indirectly involved in the Apollo program. Extensive capital investments were needed for restructuring and developing new centers. During the summer of 1962, NASA opened its Manned Spacecraft Center (renamed Lyndon B. Johnson Space Center in 1973) in Houston, Texas, to define the Apollo vehicle, train the astronauts and control manned flights. On October 25, 1961, NASA created the Mississippi Test Facility (MTF, renamed John C. Stennis Center in 1988) on the banks of the Pearl River near New Orleans, to carry out acceptance tests on the first and second launcher stages. Also close to New Orleans was the Michoud Assembly Facility (MAP), opened on September 7, 1961, for first stage assembly of the Saturn IB and V launchers. The Mississippi and Michoud facilities were both under the control of the Marshall Space Flight Center (MSFC) in Huntsville, Alabama, which had overall responsibility for launcher definition, development and testing.

The last major decision was to create the Launch Control Center in Cape Canaveral, Florida, for the final assembly of the launcher, and for the launches themselves. On November 29, 1963, this site was renamed the John F. Kennedy Center.

Some people in the United States criticized this vast effort, on the grounds that its sole aim was to compete against the Soviet Union. Not surprisingly, the Soviet Union was also a formidable critic, using psychological warfare to try and destabilize the program. The chosen target for its attacks was Wernher von Braun: the USSR used the East German writer Julius Mader to write a biography of von Braun entitled: *The Secret of Huntsville: the True Story of Wernher von Braun, Rocket Baron*. The thesis of the book was that von Braun and his German team had worked for the Nazis

in Germany. They were therefore Nazis, and the United States was using Nazis for its space efforts. Although these attacks raised some eyebrows in the U.S., they didn't hinder the smooth progress of the program.

Both sides spied on each other. The American Corona reconnaissance satellites carried out surveillance missions over the new Soviet Baikonur launch base, while the Soviets' task was made easier by the wide coverage of the Moon program in the U.S. press.

As the Apollo program got under way, the Americans and Soviets continued their rivalry in manned flights. Their respective Soyuz and Gemini programs enabled them to perfect the rendezvous techniques and orbital changes that were crucial to any Moon mission.

Thanks to the Gemini program of 1965 and 1966, the United States gradually caught up with the Soviets, even moving ahead of them in certain areas such as long duration flights. Above all, the Americans became confident that they could reach the final goal: a man on the Moon.

'The Soviets' Confused Moon Strategy

As in the United States, the need to develop heavy launchers was understood in the USSR, and was noted in particular by Sergei Korolev in 1960. The Soviet response would be the N-1 launcher, capable of meeting both civil and military requirements, and able to carry payloads of 40 to 80 metric tons.

While Korolev was working on the preliminary project for the N-1, Khrushchev made a decision which would have major repercussions on all Soviet manned lunar programs. On May 13, 1961, he asked Vladimir Chelomey to design a launcher and manned spacecraft capable of carrying at least one cosmonaut around the Moon. The launcher used would be the UR500K, or Proton, still operational today, while the spacecraft would be known as LK-1.

Another project was initiated in March 1962, under the responsibility of M.K. Yangel, the third Soviet "Constructor General." Noting that his two colleagues, Korolev and Chelomey were working on major projects, he proposed to team up with the engine manufacturer Glushko to build a rocket with much the same performance as the N-1. The specifications of the N-1 were approved in July 1962: it would weigh 2,200 metric tons and have a payload capacity of 75 metric tons, but would not be used for Moon shots.

At this stage, the USSR had not been planning to put a man on the Moon. With their strong track record of past successes, they refused to believe that the Apollo program would actually succeed. However, they did realize that Apollo was

making real headway, and encouraged by Korolev, the Soviet authorities finally set two objectives on August 3, 1964:

- The N-1-L-3 launcher, under the responsibility of Korolév, would put a Soviet on the Moon in 1967-1968.
- Chelomey's UR500K (Proton)/LK-1 (Zond) manned spacecraft program would carry out a lunar flyby mission in the second quarter of 1967.

The difference between the two countries' strategies was that the United States was focusing on a single program (Saturn/Apollo) to achieve these two objectives, while the Soviet Union was engaged in two programs, dividing its efforts and resources.

In the meantime, the N-1 program was not doing well. Korolev considered that liquid hydrogen/ oxygen engines were essential, but Glushko overruled him, declaring that *"oxygen is far from being the best oxidizer, while hydrogen is simply not a practical solution and has no future as a fuel."* Liquid oxygen was therefore abandoned in 1962, although the idea would be resurrected in 1974!

Korolev and the N-1 program were also competing with two other projects: Chelomey's UR700 launcher, derived from the Proton, and Yangel's R56, both of which planned on using Glushko engines. The R56, with a liftoff weight of 1,400 metric tons, would be able to inject 50 metric tons into Earth orbit.

However, Khrushchev was dismissed from office in October 1964, and Chelomey lost his patron. A few months later, in March 1965, the space sector was reorganized, and in December, Korolev took control of the two Moon programs. But in January 1966 Korolev died, and was replaced by Vasily Mishin. As work continued, a number of problems arose and hopes of keeping to the original schedule seemed increasingly unrealistic. This led to further tension between Soviet leaders and technicians. On a regular basis, technicians were called to the Kremlin to be reprimanded. These *"intimate meetings with the Kremlin apparatchiks amounted to nothing more than a round of abuse and obscenities,"* Chelomey would later assert. Space program heads were threatened and abused, particularly Chelomey who in 1965 no longer had a protector within the Kremlin. Returning from one of these meetings, Chelomey confided in one of his colleagues: *"They hope to inspire us to greater exploits for the motherland by swearing at us! They would be better off saying nothing at all if they can't tell the difference between a home-made still for brandy and a rocket!"*

Relations between the two research bureaus were hardly any better. On September 12, 1965, M. Gurevitch, a colleague of Chelomey's, who had just attended an inter-ministerial meeting noted: *"I observed a 'native' of OKB1 [headed by Mishin] show exemplary 'benevolence' towards our boss Chelomey. While Chelomey was giving a talk, the other kept making a string of critical comments. I ended up asking him*

whether Chelomey had nonetheless said anything sensible. He immediately replied: 'of course not, it's nothing but drivel.'"

General Kamanin, the cosmonauts' patron, was hardly any more comforting in his diary notes of October 8: *"I've just read the report on the American space program that the U.S. president delivered to Congress. Since 1954, they have poured \$34 billion into their space programs. Impressive! We've spent far less money and have had organizational problems. Although it might seem paradoxical, we don't even have a government body to organize space activities!"*

While work on the N-1 launcher progressed, another complex was under construction 2,100 kilometers from Moscow. This was at Baikonur, one of three Soviet space centers. As for Proton, two complexes were initially going to be built, each with two launch pads, but because of holes in the budget, only one complex was eventually given the green light. Construction of the first launch pad, closely monitored by American spy satellites, began in 1964 and was completed in 1967. Construction of the second launch pad lasted from February 1966 to the end of 1968. Two 145-meter pivoting service towers had been planned for each launch pad, but again, only one was built due to a shortage of funds.

1967-1969: Americans and Soviets Neck-and-Neck

The period 1967-1969 constituted the final phase for both the U.S. and Soviet manned lunar programs.

The year 1967 opened with tragedy for the Americans. On January 27, Virgil Grissom, Ed White and Roger Chaffee perished in a fire in the Apollo-1 command module. This delayed the program by several months, leaving people to wonder whether President Kennedy's promise of a man on the Moon before the end of the decade could really be fulfilled. But despite the setback, work on the Saturn I, IB and V programs and the Apollo program was moving along satisfactorily. All 17 missions between 1961 and 1967 were successful.

In the Soviet Union, the Proton/Zond Moon flyby mission series kicked off in March. The four launches that took place in 1967 were all failures. This delayed the Zond program, while the N-1-L-3 program was also running into trouble. Then it was the turn of the Soviets to suffer a tragic accident: in April, 1967, cosmonaut Vladimir Komarov died during the first Soyuz mission. But in October, the Russians managed the first automated rendezvous of two Soyuz spacecraft.

The United States achieved its first major Moon success in 1968. On December 24, Apollo 8 and its crew circled the Moon. For the first time, the United States achieved a major milestone before the Soviet Union. On account of American success, the Soviets canceled their Zond program, of which none of the launches had been a

total success. The Soviets had indeed been the first to send living beings round the Moon in September, aboard Zond-5. But this had involved only turtles and insects, and the achievement paled into insignificance compared with Apollo-8.

1969-1972: The United States Triumphs

The United States definitively triumphed over Soviet Union in 1969. The first launch of the N-1-L-3 on 21 February ended in an explosion, as did the second on July 3. Aware of how difficult it would be to beat the Americans, the Soviets had launched a backup program using automatic probes. Not only did they hope to bring back lunar samples before Apollo-11, but they also intended to prove that they could do so without risking the lives of cosmonauts. The war of nerves continued unabated.

On July 13, Luna-15 was launched from Baikonur to bring back lunar samples. Three days later, Apollo-11 was launched from Cape Canaveral. The rest is history: on July 21,* Neil Armstrong and Buzz Aldrin became the first men to walk on the Moon, at the same moment that Luna-15 crashed a few hundred kilometers from the Sea of Tranquillity. The United States had won the Moon race and the humiliation of Sputnik was finally erased.

From that historic date until 1972, a total of 12 Americans walked on the Moon. Not even the ill-fated Apollo-13 mission in 1970 would tarnish this success, since NASA was ultimately able to transform this accident into a tale of triumph over adversity. The end result of the Moon race was that only the United States was able to launch manned missions to another planet, while the Soviets had to stay closer to Earth. Of course, it had taken the Americans 12 years to catch up with the Soviets and seize the ultimate prize of the Space Race.

The Soviets' final record was very disappointing. All four N-1-L-3s had exploded and only two of the 11 Zond flights - all unmanned - were successful.

1975: The Apollo-Soyuz Truce

After the space wars came, not peace, but a truce. On July 17, 1975, Apollo and Soyuz spacecraft linked up in orbit. An historic handshake took place above Earth between American astronaut Thomas Stafford and Soviet cosmonaut Alexei Leonov, who declared: "*The Space Race is over, and it was a draw.*"

Between 1970 and 1976, the Soviets continued to send probes to the Moon, capitalizing on expertise developed during the Moon race. These probes brought back 330 grams of samples, versus the Americans' 380 kilograms.

* July 20 in the United States, July 21 in Europe, the USSR and Asia (ed.)

1975-1991: Final Skirmishes

The “Space Race” between the two super powers was not entirely over. Throughout the early 1970s, they continued to compete with their respective space station programs, Salyut and Skylab, while in the following years, both countries developed a space shuttle. In 1981, the American Space Shuttle made its maiden voyage, while the Soviet version, Buran, didn’t fly until 1988. This unmanned flight proved the Soviet’s expertise in this area. However, Buran has made only the one flight to date.

One War Ends, Another Begins

The ideology underpinning the Space Race was fatally damaged in 1991, when the USSR was dissolved, giving way to Russia and the Commonwealth of Independent States (CIS). An era in space history had come to an end.

Today, the ex-Soviet launchers Proton, Zenit and Soyuz are marketed by American and international companies, such as ILS, Sea Launch and Starsem. All space powers are cooperating in the construction of an international space station. Another example of cooperation is the American launcher Atlas III, for which Russia is supplying its RD180 engines.

Ideology, spectacle and publicity coups no longer drive the space industry: in their place, commercial applications are becoming increasingly important.

A new era in space is dawning.

Moon Race Chronology

	UNITED STATES	SOVIET UNION
1961	John F. Kennedy's speech to Congress Apollo program begins	
1962		
1963		
1964	First Saturn 1 orbital flight, unmanned	Proton/Zond (lunar flyby) and N-1-L-3 (Moon landing) programs begin
1965		First Proton flight
1966		Death of Korolev
1967	Deaths of Grissom, White, Chaffee First Saturn V flight, unmanned, sends Apollo-4 into Earth orbit and re-entry	First Proton/Zond flight (failure) Death of Komarov
1968	2nd Saturn V flight, unmanned, sends Apollo-6 into Earth orbit First manned Apollo mission (Saturn-IB/Apollo-7) <u>First manned circum-lunar flight</u> (Saturn V/ Apollo-8)	Death of Yuri Gagarin
1969	<u>First men on the Moon</u> (Saturn V/ Apollo-11) Second manned Moon landing (Saturn V/ Apollo-12)	First unmanned N-1 flight (failure) Second unmanned N-1 flight (failure) 10th Proton/Zond flight and first successful <u>Soviet unmanned circumlunar</u>
1970	Apollo-13 accident	11th and last Zond mission - <u>End of Zond program</u>
1971	3rd manned Moon landing (Saturn V/ Apollo-14) 4th manned Moon landing (Saturn V/ Apollo-15)	Deaths of Dobrovolsky, Patsayev and Volkov 3rd unmanned N-1 flight (failure)
1972	5th manned Moon landing (Saturn V/ Apollo-16) Last manned Moon landing (Saturn V/ Apollo-17) <u>End of Apollo program</u>	4th unmanned N-1 flight (failure)
1973		
1974		<u>End of N-1-L-3 program</u>
1975	Apollo/Soyuz rendezvous	