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Soviet space program entered 1967 at a hectic pace. An undeclared race with the United States to land a man on the Moon was quickly approaching its climax. A new spacecraft paving the way to lunar landing was undergoing difficult flight testing in the Earth orbit, while its creators planned ever more complex missions into deep space.

#### True and half-true

On April 23, 1967, after a more than [two-year gap](#) in the manned space flight, the Soviet Union announced the launch of a new-generation spacecraft called Soyuz-1 ("Union") with a veteran cosmonaut Vladimir Komarov onboard. Customary for the secretive Soviet system, an official communique about the launch contained generalized statements about testing a new spaceship but little substance on its design or its mission. Even more shocking was the April 24 communique informing the world that Komarov tragically died during landing due to the failure of the parachute system.

In the following two decades, Western observers carefully put together bits and pieces of available information and imagery, which enabled them to paint a rough, but credible picture of events surrounding the Soyuz-1 mission. In the meantime, inside the Soviet Union, informational vacuum left plenty of room for a decades-long whirlwind of incredible rumors.

Only on June 11, 1989, the *Komsomolskaya Pravda* newspaper ran an article by a veteran Soviet journalist Yaroslav Golovanov, revealing crucial details about Komarov's fateful mission. Most importantly, Golovanov confirmed to the Soviet public what Western observers had suspected from the outset -- Komarov's flight plan was much more ambitious than official press had officially admitted. Although Soyuz-1 returned to Earth after a 24-hour long "solo" flight, its original goal would be to dock with a second Soyuz manned by three cosmonauts, Golovanov wrote. However problems onboard Komarov's spacecraft forced cancellation of the second launch, likely saving lives of three more cosmonauts, whose vehicle had the same catastrophic flaw, which doomed Komarov.

Several years of Golovanov's publication, Boris Chertok provided an unprecedented first-hand account of the Soyuz-1 flight, shedding light on a behind-the-scene drama, which played out during the mission.

#### Pre-flight developments

Launches of unmanned versions of the [Soyuz spacecraft](#), which preceded Komarov's flight, exposed numerous flaws. Serious problems, which would certainly lead to death of their passengers had they've been onboard, were uncovered. Cautious engineering thinking dictated another "clean" unmanned launch, before Soyuz could be certified to carry people. However, it is widely believed that technocrats preparing the first Soyuz for flight were under pressure from their political bosses to have a "space spectacular" as soon as possible. By 1967, the USSR did not orbit humans for two years and the upcoming Day of Workers Solidarity on May 1 would be a perfect time for the Soviet leadership to remind the world about "achievements of the socialist system."

The first mission of Soyuz would also coincide with the summit of the Soviet block leaders in Karlovy Vary, Czechoslovakia, giving Soviet leader Leonid Brezhnev something to be proud off.

At least one Russian source names Dmitry Ustinov, a powerful member of the Soviet Politburo overseeing rocket industry, as the main force, hammering out deadline for the Soyuz-1 flight. Ustinov reportedly held numerous meetings on the issue and personally pressured [Vasily Mishin](#), the head of the TSKBEM design bureau developing Soyuz, to fly on the eve of the Karlovy Vary summit. According to the source, Ustinov also threatened cosmonaut Vladimir Komarov, still skeptical about the Soyuz's readiness for flight, to "remove stars from his chest and shoulder straps," unless he agrees to pilot the vehicle. (245)



Komarov inside the Soyuz trainer. Credit: RKK Energia



Komarov (right) and Gagarin, his backup for the Soyuz-1 mission.



Original members of the Soyuz-1 and Soyuz-2 crews and their backups (left to right): Gagarin, Khrunov (in EVA suit), Komarov, Yeliseev (in EVA suit), Bykovsky

After three unmanned test flights, Ya. I. Tregub and K. Bushuev, leading engineers at the TsKBEM design bureau, held a series of meetings, considering "man-rating" Soyuz. Ultimately, the issue had to be resolved at a crucial meeting, hosted by Vasily Mishin, where all key developers of the Soyuz were reporting on the state of readiness of their respective systems. Perhaps not without underlining pressure of the [space race](#), the majority called for the manned attempt. I. S. Prudnikov apparently was a lone dissenter, still unsure about the thermal protection system, which failed in a previous unmanned launch.

Nevertheless, with a number of corrective actions in place, Soviet space officials decided to proceed with not only a manned test flight but with an ambitious orbital rendezvous mission. The Ministry of General Machine building, overseeing the Soviet rocket industry, as well as Military Industrial Commission, VPK, later blessed the decision, which was then reported to the Central Committee of the Communist Party. (52)

### Flight program

The Soyuz-1, would be to be launched first carrying Vladimir Komarov. The spacecraft would be equipped with an "active" docking mechanism, making it responsible for most maneuvers during the rendezvous.

A day later, the second Soyuz equipped with a "passive" docking port, and carrying three cosmonauts would follow. Two vehicles would linkup in orbit and a pair of cosmonauts from the second Soyuz would don their spacesuits, exit their ship via a hatch in the [habitation module](#) and crawl to the Soyuz-1 through open vacuum of space. A spacewalking pair would return to Earth along with Komarov, while the remaining cosmonaut onboard Soyuz-2 would touch down alone. (246)

### Last preparations

On the morning of **April 14, 1967**, a number of high-ranking space officials including Vasily Mishin and Boris Chertok flew to [Baikonur](#) to oversee final preparations for the first Soviet manned launch in more than two years. On the evening of the same day, at [Site 2](#), Kerim Kerimov chaired a crowded meeting of the State Commission, which reviewed pre-flight processing of two Soyuz spacecraft and cleared them for fueling. Yurasov, who was in charge of pre-launch processing, reported on various aspects of the work. Next, Yurasov's associate Colonel Kirillov also spoke, pointing out hundreds of issues, which came up during tests. He concluded that vehicles are still "undercooked." In response, Vasily Mishin went into rage and sharply told Kirillov that he "would teach him how to work." (27)

General Kerimov reconvened the State Commission on the evening of **April 20, 1967**. The commission formally confirmed launch time, primary crews and backup crews, as proposed by General Kamanin of the Air Force:

	7K-OK No. 4 (Soyuz-1)	7K-OK No. 5 (Soyuz-2)
Launch time	1967 April 23, 03:35 Moscow Time	1967 April 24, 03:10 Moscow Time
Commander	Vladimir Komarov	Valery Bykovsky
Spacewalker 1	-	Aleksei Yeliseev
Spacewalker 2	-	Yevgeny Khrunov
Backup commander	Yuri Gagarin	Andriyan Nikolaev
Spacewalker 1 backup	-	Viktor Gorbatko
Spacewalker 2 backup	-	Valery Kubasov

On **April 21, 1967**, Chertok and a number of other space officials flew to the NIP-



Komarov during EVA training.



Komarov (left), Gagarin (center), Bykovsky (right) apparently arriving to the meeting with the launch personnel at [Site 1](#) in [Baikonur](#) on April 22, 1967.



16 [ground control station](#) in Crimea, which would be the main nerve center of the mission.

On the morning of **April 22, 1967**, launch personnel, the crew and other officials held a meeting in the shadow of the [Soyuz launch vehicle](#) erected on the launch pad at [Site 1](#). The event left numerous photographs, some of which were published during the Soviet period, giving independent analysts evidence that along with Komarov, a number of other cosmonauts were ready to fly at the time.

After a sleep period, which started in the middle of the day for many of the officials involved in the mission, the State Commission gathered for the "launch meeting" starting at 23:30 Moscow Time. Everything was declared ready for flight and the fueling of the launch vehicle was completed by 3:00 in the morning of **April 23, 1967**.

Komarov and Gagarin arrived to the pad by bus and both rode an elevator of the access gantry to the top of the rocket. As described by Yaroslav Golovanov, Komarov was wearing gray pants and blue jacket. (246) Cosmonauts exchanged "see you soon," and Gagarin watched as the entry hatch into the Soyuz-1 was sealed behind Komarov.

### The flight, April 23

The spacecraft 7K-OK No. 4 blasted off from Baikonur's Site 1 on **April 23, 1967**, at 03:35 Moscow Time, exactly as scheduled. It would be officially announced to the public as Soyuz-1. Observers noticed that unlike Vostok and Voskhod, the very first spacecraft in the series was given a number, perhaps another hint that a second launch was imminent.

Exactly 540 seconds after launch, the NIP-16 ground control station manned by Chertok and other key officials received news that the spacecraft separated from the launch vehicle and reached a nominal orbit. As Chertok wrote "we all applauded, but immediately realized that formally flight control was now transferred to us."

A very first report based on telemetry data received by NIP-4 and NIP-15 ground control stations informed flight managers that all antennas had deployed, however the left solar panel, critical for power supply onboard, did not open. Ground controllers were yet to see the reduced flow of electricity from panels and until Soyuz-1 would reenter the communication range over the USSR, they held hope that solar array did open, but the sensor confirming the operation did not work properly.

In the meantime, a team analyzing the telemetry from the spacecraft reported that a backup antenna of the telemetry system did not deploy, as well as the cover protecting the 45K star and sun sensor did not open, due to obstruction of the undeployed solar panel. Without a star sensor, Soyuz-1 could not maintain an attitude control, necessary for all crucial maneuvers, including spin-stabilization of the craft, or engine firings.

During the second orbit, as Soyuz-1 reappeared in the communication range, Komarov established voice contact with the ground. He confirmed that the left solar panel did not deploy and neither automatic or manual attempts to initiate spin stabilization of the spacecraft succeeded. In addition to the reduced power supply, the unopened solar panel created an asymmetry in the configuration of the spacecraft, which made attitude control difficult. (27)

According to Golovanov, Komarov even knocked with his feet on the side of the spacecraft, where a simple but stubborn deployment mechanism for the solar array was located, however without success. (246)

Chertok and other flight managers in Crimea realized that preparation for landing should start as soon as possible, while Soyuz-1 still had "juice" in its batteries. However they were preempted by the State Commission, which advised Komarov to repeat attempts to establish spin stabilization of the spacecraft.



A pre-launch ceremony on the launch pad at [Site 1](#) in [Baikonur](#) on April 22, 1967.



The [Soyuz rocket](#) on the [launch pad](#) in [Baikonur](#).



Komarov (left) and Gagarin walk toward the Soyuz-1 spacecraft, shortly before its launch.

Not until 10:00 in the morning on April 23, 1967, the State Commission officially confirmed an inevitable decision to cancel the launch of the Soyuz-2 and prepare a plan for landing of Soyuz-1 during its 17th orbit, with a backup reentry opportunities during 18th or 19th orbits.

In the meantime, in orbit, Komarov struggled to recharge batteries onboard Soyuz-1. He repeated attempts to spin-stabilize the spacecraft during the 13th orbit. According to ground control stations, which maintained contact with Komarov at the time, despite all his efforts, "Sun current" (power supply from solar panels) did not exceed 12-14 Amperes. In the meantime, in order to fully recharge the battery, it needed input of 23-25 Amperes. Ground controllers responsible for power supply systems estimated that after the 17th orbit, Soyuz-1 could be forced to switch to a backup battery and they advised flight managers not to postpone landing beyond the 19th orbit.

When, around 11:00, Soyuz-1 entered a prolonged period out of range of ground control stations, flight managers attempted to summarize all available information and devise a plan for landing. In addition to problems with power supply, continuous attempts to establish attitude control led to excessive use of propellant.

During the 14th orbit, the head of ballistic team Yastrebov warned flight managers that they have to end their endless discussions within next half an hour and make a decision on the flight plan, if they wanted his team to have enough time to calculate all the parameters and prepare instructions to be transmitted onboard Soyuz-1 for landing.

After chaotic exchanges between Crimea and the State Commission at Site 2, officials finally settled for a landing during the 17th orbit. Komarov was supposed to use ion sensors, which also displayed problems during the flight, to orient the spacecraft in the right direction, before the braking engine is fired.

During the 16th orbit, Gagarin, who was posted in Crimea, related Komarov final instructions for landing. In remaining few seconds of the communication session, Mishin and Kamanin wished Komarov a safe return.

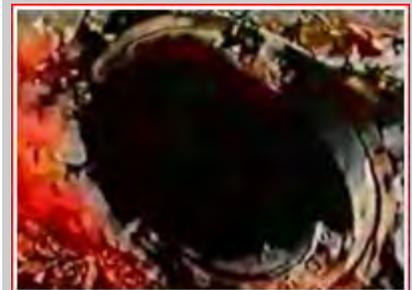
### Return, April 24

As Soyuz-1 flew its 17th orbit, the ground control station in Crimea tracking the flight, determined that the spacecraft's trajectory have not changed and it was not following projected landing path. Komarov soon entered communications, explaining that he initially succeeded in establishing attitude control of the spacecraft with the use of ion sensors, however somewhere near the Equator, the vehicle deviated from proper orientation and the flight control system blocked upcoming firing of the braking engine.

Flight managers rushed to plan another attempt on the 18th orbit, however as Soyuz-1 went out of range, no new instructions were sent to Komarov. When finalized, the new reentry plan called for Komarov to manually orient the spacecraft during orbital daylight, then, when it enters night side of the orbit, a reliable KI-38 gyroscopes would maintain the attitude control. As spacecraft emerges from the shadow, Komarov could again correct the orientation manually, as Soyuz would go through reentry sequence during the 19th orbit. In the meantime, Yablokova, a chief engineer responsible for power supply, approached Chertok. She warned him that available resources of the primary battery would work for another orbit or two, a backup battery would supply power for three more orbits.

As the new communications period started, Gagarin relayed Komarov latest instructions, which included:

- At 05:00 initiate manual attitude control during daylight portion of the orbit;
- Turn the spacecraft 180 degrees (tail first) in preparation for a braking engine firing;
- Prior to entering a night portion of the orbit switch attitude control to KI-38 gyroscopes;
- Upon exiting the night side, conduct manual correction of the attitude and keep maintaining it;



Burning remains of the Soyuz-1 reentry capsule at the crash site.



An improvised memorial ceremony at the site of Komarov's death. Credit: RKK Energia

- At 05:57:15, activate braking engine with burn time of 150 seconds;
- After a 150-second burn, if engine is not shot down by a sequencer, turn it off manually;

According to Chertok, Komarov was not specifically trained for this type of flight mode, but was ready to implement it.

Next opportunity to hear from Komarov came during the landing orbit. By that time, communications were coming via a small antenna in the [reentry capsule](#), since Soyuz-1 had already went through separation of its main sections.

Komarov reported that the braking engine was activated at **05:59:38.5** and fired for 146 seconds. At **06:14:09**, the Failure-2 command interrupted the burn. Komarov's words then drowned in the background noise.

Boris Raushenbach, who was responsible for the flight control, explained that because of the asymmetrical shape of the spacecraft with only one solar panel open, attitude control thrusters were not able to maintain proper orientation long enough for the entire duration of the braking maneuver. As a result, the gyroscope generated Failure-2 command, when deviation from the nominal attitude exceeded eight degrees. However Raushenbach also had a good news: the braking maneuver was long enough to guarantee the reentry into the Earth atmosphere.

In the aftermath of the Failure-2 command, the attitude control system of the reentry capsule remained turned off. As a result, the [reentry capsule](#) was descending on a ballistic trajectory, without an aerodynamic lift, which would be possible in the nominal landing profile. (27)

As a result of the ballistic reentry, which shifted the landing site for the Soyuz, a backup recovery and rescue team, (deployed in the city of Orenburg) would be responsible for the landing. It included a technical team from TSKBEM led by E. P. Utkin. (52)

At 06:22, the Soviet anti-aircraft radar detected the reentry capsule. It was projected that the Soyuz-1 would land 50 kilometers east of Orsk at 06:24 on April 24, 1967.

Personnel in Crimea had never received a confirmation about the successful landing. Chertok's description of the fateful morning mentions Gagarin's fruitless efforts to penetrate paranoid secrecy of the Soviet military in order to get any news about Komarov. (27)

### The crash

One of eyewitness accounts of the Soyuz-1 landing is provided by Oleg Bychkov and Viktor Artamoshin, flight surgeons who were members of the Operational Tactical Search and Rescue Group, OTG, deployed at the airfield near Orsk (245):

At six o'clock the entire search and rescue team was brought to Level 1 readiness. Planes and helicopters took off into the air. Soon a helicopter carrying the Operational Tactical Group, OTG, arrived to the landing area. The commander of one of the Antonov-12 search aircraft reported that it saw Soyuz-1 in the air. Immediately, everybody onboard the helicopter rushed to the windows, however could not see the spacecraft themselves. The pilot of the helicopter started a fast descent, followed by a sharp right turn, when many members of the group saw the [descent module](#) landed on the green field. It was lying on its side, with the parachute seen next to it. And immediately soft-landing engines fired. That alarmed the specialists onboard the helicopter, as the engines should've activated before the touchdown, just above the ground.

The helicopter, carrying Bychkov and Artamoshin, landed some 70-100 meters from the reentry capsule, above which towered a cloud of black smoke. Everybody rushed to the capsule, but only upon reaching it, realized that the pilot would no longer need help. Fire inside the spacecraft was spreading and its bottom completely burned through with streams of molten metal dripping down. (245)

In the meantime, another search team, including TSKBEM specialists, departed Orenburg onboard the Ilyushin-14 aircraft. They detected the [reentry capsule](#) on the ground, not far from the village of Karabulak in the Orenburg Region, The parachute was spread next to the capsule, and signs of fire were visible from the

plane.

A group of parachutists was dropped at the site, where rescuers discovered the reentry capsule crashed and burning. Rescuers used portable fire extinguishers to suppress the flames. (52)

According to Golovanov, rescue teams were equipped with sets of colored flares, which could instantly provide code signal to the aircraft overhead about the situation on the ground. However, there was no code for "death of cosmonaut," therefore rescuers fired a flare, which stood for "Cosmonaut requests urgent medical assistance." (246) This code signal apparently led to a wide-spread confusion and unfounded hope among space officials that Komarov survived the crash.

According to Buchkov and Artamoshin, foam fire extinguishers were not enough, therefore rescuers shoveled dirt on the vehicle. While they battled flames, the reentry capsule completely collapsed, leaving behind just a pile of dirt topped with the entry hatch.

As soon as the fire ended, doctors from the OTG started a recovery effort -- using shovels they removed dirt from the entry hatch to get access to the remnants of the interior. After removing more dirt and some fragments of instruments and avionics, rescuers discovered Komarov's remains in the central seat of the capsule. They went through a grim task of cleaning dirt from the head, still with remnants of a burned headphone. They formally pronounced Komarov's death from multiple injuries to the skull, spinal cord and bones. (245)

Back at TsKBEM near Moscow, engineers were able to listen to communications of the recovery and rescue teams. However the link went dead, apparently sometimes before projected landing. As tension at the bureau was mounting, the news came that Komarov had died.

A number of high-ranking officials rushed to the crash site. Among them G. A. Tyulin, the Chairman of the State Commission overseeing flight testing of the [Soyuz spacecraft](#), [Vasily Mishin](#), M. Keldysh, F. D. Tkachev and Gai Severin, the head of the [Soyuz systems](#) development, along with ever-present KGB security officers. A fast-reaction investigation team at the crash site included P. Tsybin, S. N. Anokhin, A. F. Topol, V. I. Ryzhikov, A. G. Reshetin, A. S. Barber. (52)

Komarov's remains were removed from the capsule and a team led by Lt. General N. P. Kamanin delivered them to Moscow. The postmortem examination confirmed preliminary conclusions by field doctors that Komarov's death was caused by the impact on the ground. (245)

### **The Soyuz-1 accident investigation**

Three days after the crash, most recovered debris from the Soyuz-1 were sent to Moscow. A number of smaller pieces were buried right at the site under a small dirt monument topped with a Air Force cap left by S. N. Anokhin. A machine gun salute was fired in the memory of Vladimir Komarov.

V. V. Utkin, Chief of Flight Research Institute of the Aviation Industry, LII MAP, was appointed the head of governmental investigation commission. Vasily Mishin and K. Bushuev became its members. After several experiments, the commission had established that a pack containing the main parachute did not come out from its parachute container. The flight control system registered an excessive speed of the capsule and reacted by releasing a backup parachute. However the backup parachute abstracted by a smaller braking parachute, which remained attached to the unopened main parachute, failed to deploy as well. (52) Another source also says that spinning of the capsule prevented nominal opening of the parachute.

As a result, the [reentry capsule](#) hit the ground with the speed of around 26-30 meters per second or 200 kilometers per hour. (245)

Once the sequence of events was restored the commission attempted to determine the cause of systemic failures. The commission officially concluded that the braking parachute, which was responsible for pulling the main parachute from its container, did not provide enough force, necessary to do the job. This could be a result of the air pressure inside the reentry capsule, pushing against the cylindrical parachute container, which was exposed to a low-pressure environment of the upper atmosphere. Despite previous tests of the parachute systems, including four drops of the capsule from the aircraft, the problem had never manifested itself. The

commission explained that by randomness of the situation.

The commission also considered a theory about improper packaging of the parachute, which was dropped after an additional analysis.

The commission made several recommendations to facilitate the release of the parachute system in future flight:

- To change the shape of the parachute container from cylinder to a cone;
- To increase volume of the container;
- To polish the internal walls of the container;
- To install an additional emergency separation interface for the braking parachute;
- To introduce step-by-step photo-documentation of the parachute installation;

#### Unofficial version of events

After the investigative commission formally ended its work, another unofficial explanation for the parachute system failure has emerged. Boris Chertok, a key figure at OKB-1 design bureau laid out this scenario in his memoirs (27) and it also made it into the official history of the design bureau. (52)

According to the theory, the parachute container onboard Soyuz-1 could've been contaminated by a glue-like polymer-based thermal protection material, which is applied to the exterior of the reentry capsule. According to Chertok, first unmanned Soyuz capsules were placed inside a special autoclave to polymerize the thermal protective layer without parachute containers, whose production lagged behind schedule.

By the time the reentry capsule of the Soyuz-1 went into the autoclave, parachute containers had been installed but their covers were still unavailable. As a result, Chertok hypothesized, a flight-ready parachute containers on the Soyuz-1 could be protected with a temporary covers during the polymerization process, which could let glue-like substance to get inside.

A fatal flaw had never had a chance to manifest itself during aircraft drop tests, since the capsules used in those tests had been covered with regular foam and never had to go through polymerization. (27)

Konstantin Feoktistov, one of leading Soyuz developers, in his memoirs expressed skepticism about such scenario, noting that production documentation did not provide any supporting evidence to support the theory. Feoktistov also questioned whether both internal control at the production plant and an outside military-run inspection could miss the issue. (196)

In any case, after the loss of Soyuz-1, new regulations required the removal of parachute containers from the reentry capsule, before its installation in the autoclave.

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