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DEPARTMENTS

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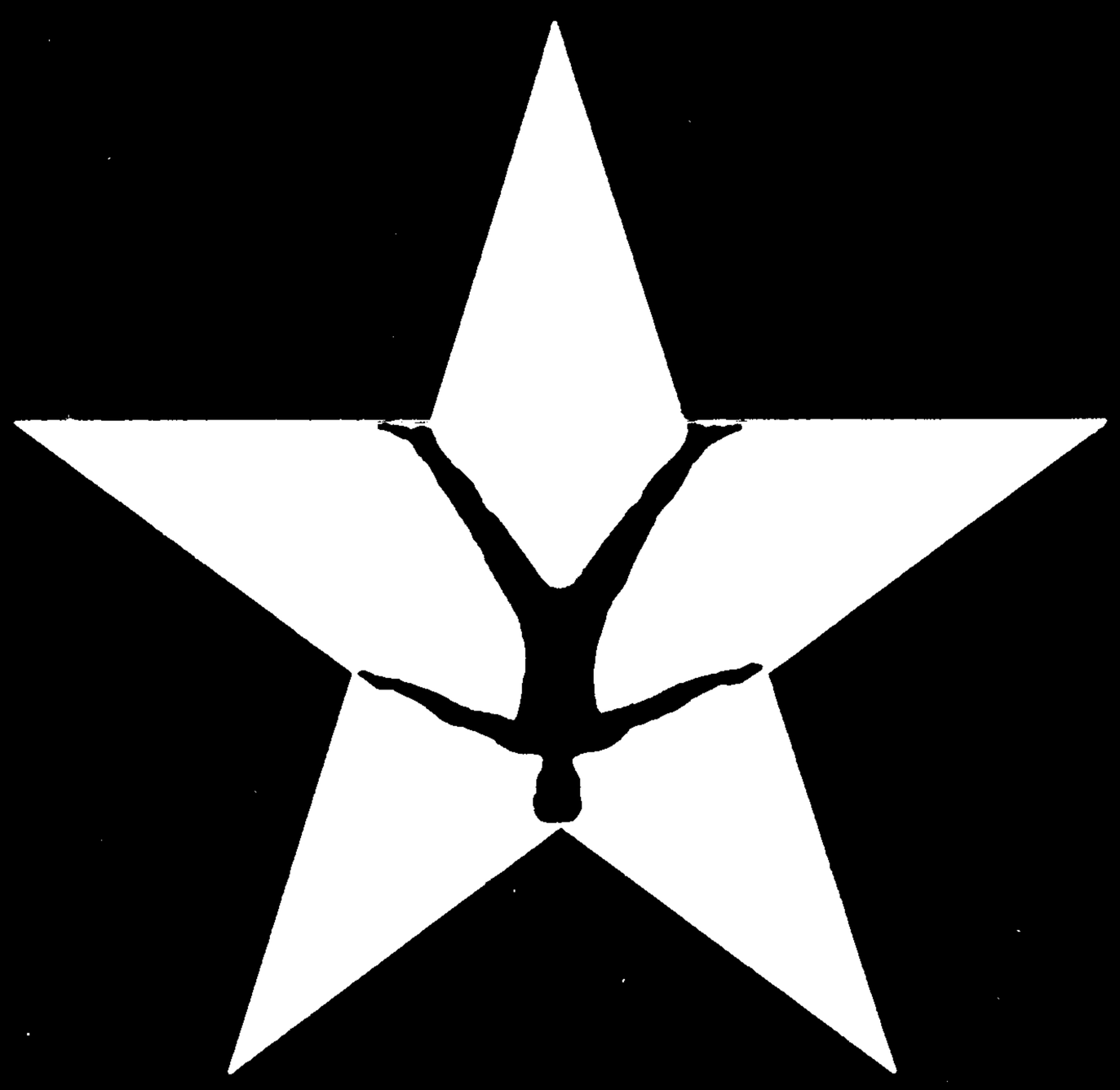
MOURNING STAR

by Asif Siddiqi



On October 24, 1960 the greatest accident in the history of rocketry and space exploration occurred. During the first attempted test of a new Soviet missile, a pad explosion produced a massive fireball killing hundreds of key soviet workers and space engineers. Called the Nedelin Disaster, accounts of the incident remained obscure for over thirty years until now. . .

On October 26, 1960, the official newspaper of the Communist Party of the Soviet Union (CPSU) published a report on the death of one of its top military commanders. The article included the following passage:

The CPSU Central Committee and the USSR Council of Ministers with deep regret announce that on 24 October of this year, while performing his service duties, Chief Marshall of Artillery Mitrofan Ivanovich Nedelin died as a result of an aircraft accident. He was a CPSU Central Committee membership candidate, deputy of the Supreme Soviet, Hero of the Soviet Union, deputy minister of defense, and commander-in-chief of the USSR Missile Troops. Marshall Nedelin was one of the outstanding military figures and builders of the Armed Forces of the Soviet Union and an illustrious hero of the Great Patriotic War.[1]

What the account did not disclose was that Marshall Nedelin and hundreds of others had perished in, without doubt, the most tragic accident in the history of rocketry and space exploration. During the first attempted test of a new missile, a pad explosion resulted in a fireball that effectively incinerated and burned hundreds of individuals within close range, and devastated the entire launch area.

News of the incident was completely suppressed from both the Soviet public and the West for almost thirty years, creating an almost unbreakable veil of silence over the tragedy. Although the Soviets themselves were tight lipped about the incident, obscure hints did find their way to the Western press allowing analysts to piece together a reasonable reconstruction of the events. As early as the end of 1960, rumors surfaced that it was a booster explosion and not an airplane crash that was responsible for Nedelin's death.[2] In a March, 1961 report, the Committee on Science and Astronautics of the U.S. Congress described how "Marshall Nedelin was killed with a large group of other officials while observing a spectacular rocket launching which exploded, [although] this could not be confirmed."[3] Further implicit confirmation of the event came from Col. Oleg V. Penkovsky, the individual who had passed along defense and state secrets to the C.I.A. until he was arrested in 1962. His alleged diaries were published in the West in 1965 after he was executed, as *The Penkovsky Papers*. Penkovsky described the test of a nuclear-powered rocket which had failed to ignite at launch. A few minutes following the abort, according to Penkovsky, Nedelin and many others came out of their bunkers, when there was a massive explosion killing "over three hundred people."[4] The author notes that there was a long period of mourning declared in the town of Dnepropetrovsk, from where some of the deceased scientists had lived.

The final conclusive confirmation that the accident had indeed occurred came from the second volume of memoirs of former Soviet leader Nikita S. Khrushchev, published in 1974 in the United States. In his writings, Khrushchev makes no mention of a nuclear rocket, but does add some interesting elements to the story:

Chief Designer Yangel just barely escaped death in a catastrophic accident which occurred during the test of one of our rockets. As the incident was later reported to me, the fuel somehow ignited, and the engine prematurely fired. The rocket reared up and fell, throwing acid and flames all over the place. Just before the accident happened, Yangel happened to step into a specially insulated smoking room to have a cigarette, and thus he miraculously survived. Dozens of soldiers, specialists, and technical personnel were less lucky. Marshall Nedelin, the Commander-in-Chief of our missile forces, was sitting nearby watching the test when the missile malfunctioned, and he was killed.[5]

Although the account in Khrushchev's memoirs fairly conclusively confirmed the earlier sketchy reports, the Soviets remained quiet about the whole issue and refrained from any comment. The best contemporary Western assessment of the disaster was published in 1981 in the book *Red Star In Orbit* by U.S. researcher James E. Oberg. In his description, Oberg linked the explosion to a launch attempt of a planetary probe bound for Mars. The very first publication of a detailed account of the accident finally came in April, 1989, in the popular Soviet magazine *Ogonek*, authored by one of the witnesses to the accident, Aleksandr Bolotin. Further accounts were soon published in the Soviet press, and now it is finally possible for the first time to piece together an accurate account of the events of that tragic day in October, 1960.

The Commander

Artillery Marshall Mitrofan Ivanovich Nedelin, born on November 9, 1902, was one of the most important artillery commanders both during World War II and in the post-war years. Following an illustrious service during the war, in November, 1948 he was appointed Commander of the Chief Artillery Directorate (GAU) in the Ministry of Armed Forces, with the job of directing the adoption and operation of a new generation of longer range ballistic missiles for the artillery sector. In particular, Nedelin was instrumental throughout that period, of creating and training the first long range missile battalions in the Soviet armed forces. The early missiles, the R-1 and R-2 were essentially derivatives of the German A-4 (known to the Soviets as the FAU-2) missile, but gave valuable lessons to the artillery sector in handling, fuelling and launching operations of liquid-fuelled ballistic rockets. Throughout this period Nedelin kept in close contact with the actual engineers involved in missile design such as Chief Designers Sergey P. Korolyov and Valentin P. Glushko of the Scientific Research Institute No. 88 (NII-88). Despite a rocky start to their interactions, through the 1950s Korolyov and Nedelin developed a very close working relationship, one that facilitated the fairly quick and successful realization of the launch of the world's first intercontinental ballistic missile, the R-7 in August, 1957. Earlier in March, 1955, Nedelin had been appointed Deputy Minister of Defense for Armaments, thus becoming personally responsible for the procurement of all long-range strategic ballistic missiles in the Soviet Union. As his power grew, he also apparently had access to the top leaders of the Communist Party, something that was not readily available to engineers such as Korolyov and Glushko. It is noted in his biography that:

When it came to disputed or what seemed to be insoluble solutions at the ministerial level, Nedelin with the knowledge of the Minister of Defense turned for help directly to the leaders of the Party and the government.[6]

Contrary to conventional wisdom, Nedelin was generally known as a very thorough and careful individual. A biographer of Nedelin recently noted that:

He was distinguished by his extreme caution in judgements and actions, a kind of overdeveloped thoroughness. If he had to go somewhere, he tried to arrive at the station an hour before the train's departure, and he travelled in two vehicles, God forbid, one might break down.[7]

Korolyov himself had a great deal of respect for Nedelin and had noted that when it came to questions of quality control and delivery dates, Nedelin was a demanding and 'principled' customer.[8] Famous Soviet physicist Andrey D. Sakharov also had high praise for Nedelin:

He was a thickset, stocky man who spoke softly but with confidence that brooked no objection. He impressed me as far from stupid, as energetic and competent, and considerably more active than his predecessor....[9]

At the end of the 1950s, when Khrushchev sanctioned the formation of a special sector of the Ministry of Defense dedicated to the operation of its new strategic arsenal, Marshall Nedelin was tapped as an obvious first choice, having extensive experience in the development and operation of the R-1, R-2, R-5, R-7, R-11, and R-12 missiles. On December 17, 1959, a new service of the armed forces, the Missile Troops, was created with Nedelin as its first Commander-in-

Chief Marshall of Artillery Mitrofan I. Nedelin is shown (above right) soon after his appointment as Commander-in-Chief of the USSR Missile Troops. On the left is Colonel-General Vladimir F. Tolubko who served as Nedelin's First Deputy. Tolubko authored a noted biography of Nedelin in 1979 and himself commanded the Missile Troops from 1972 to 1985. Photo Source: Tolubko, V. F., "Nedelin: Perviy Glavkom Strategicheskikh," Molodaya Gvardiya, Moscow, 1979.

Chief.[10] Under orders from Nedelin, the most qualified and competent officers were tapped from all across the nation to be inducted into the new service, the final selections being made by Nedelin himself.

The Missile

By the time of the formation of the Missile Troops in December, 1959, the Soviet Union had in its possession only one intercontinental ballistic missile, the R-7A (the 8K74), affectionately called the 'Semyorka' (old number seven), and designed by a team under Chief Designer Korolyov at the Special Design Bureau No. 1 (OKB-1). By 1959, there were already plans at the highest level for a second generation of missiles, that would not have such limited strategic capabilities as the R-7A. One of the primary concerns for officers like Nedelin was that the R-7A would be a very cumbersome missile to use in actual wartime situations. The missile took too long to fuel rendering it virtually useless in quick reaction situations. In addition, its launch structure was relatively large and was visible to overflying reconnaissance flights leaving the pads open to targeting by U.S. bombers. The vehicle also had poor guidance capabilities, and was forced to rely significantly on expensive ground station contact during portions of its flight trajectory. To bypass these and other limitations, several proposals were floated around in the 1956-59 period that foresaw the development of an intercontinental ballistic missile which could be launched on as little as 30 minutes notice from small self-contained mobile platforms. Consequently Soviet leaders Nikita S. Khrushchev and Leonid I. Brezhnev, on May 13, 1959 formally approved the development of two unrelated missiles of the second generation. Competing for ultimate adoption by the Missile Troops, OKB-1 Chief Designer Korolyov began development of the R-9 missile (the 8K75), while Special Design Bureau No. 586 (OKB-586) Chief Designer Mikhail K. Yangel, based at Dnepropetrovsk, began work on the R-16 vehicle (the 8K64).[11]

Yangel, a protege of Korolyov's, had been appointed head of his own organization in June, 1954 to develop early quick-action intermediate range missiles such as the R-12 and R-14. By 1960, both of these missiles had flown successful test flights. Yangel's and Korolyov's missiles had one significant difference: Yangel chose to use the highly toxic and hypergolic combination of nitric acid and kerosene derivatives. Korolyov was very reluctant to use toxic fuels due to the danger in handling them. Although they could be stored in the missile for relatively long periods of time, they were also very dangerous to ground crews if not properly handled. With no interest in the 'devil's venom' (as Korolyov called nitric acid), Korolyov preferred to use the tried and tested liquid oxygen and kerosene in his new R-9 missile. Yangel however, had a successful history of using hypergolic propellants on the R-12 and R-14, making him an ideal choice to develop the R-16. Nedelin was particularly supportive of Yangel's new rocket, and with the patronage of Brezhnev, managed to bring the vehicle from the drawing boards to reality in a very short period.

The R-16, as designed in the 1958-59 period was to be the first true two-stage intercontinental ballistic missile. The first stage was powered by three two-chamber engines from the OKB-456 of Chief Designer Glushko designated the RD-218. This engine was part of a group of four that Glushko had begun working on in 1958 that used the new synthetic propellant named unsymmetrical dimethyl hydrazine (UDMH). Combined with nitrogen-derived oxidizers, the use of the propellants promised the possibility of 'storing' the missile in firing position for longer periods of time. Total sea level thrust at lift-off for the R-16 was 255.4 tons.[12] The second stage was to utilize the two-chamber RD-219 engine fuelled by red fuming nitric acid (RFNA) and UDMH. Total thrust was to be about 80 tons.[13]

Guidance on the R-16 was to be handled by a fly-by-wire inertial guidance system. It was to use a preprogrammed variable thrust/altitude history in order to maintain the required velocity and position through its long trajectory. Since real time solutions were not expected of the complex guidance equations, simple analog computers and digital-differential analyzers were planned for use with the missile in place of more advanced digital computers.[14] The initial model of the missile was to carry a single 5.0 megaton nuclear warhead a distance of 13,000 kilometers.[15] The length of the missile was to be 30.78 meters, about the same size as the famous 'Semyorka.' Base diameter was to be 3.05 meters. The leading designer of the missile was Deputy Chief Designer of OKB-586, L. A. Berlin. Another Deputy from the Design Bureau, V. A. Kontsevoy was appointed to direct and oversee the complete testing program on behalf of the engineers.

The People

The first ground tests of the engines for the R-16 began in late 1959 at Khimki under the direction of Chief Designer Glushko. By the summer of 1960 ground crews were sent to Tyura-Tam to begin construction of a launch pad at site number 41 in preparation for the first launches of the missile later that year. By the autumn, construction of the first pad was finished, and by early October, personnel from the Yangel Design Bureau, the Missile Troops, and the State Committee for Defense Technology began to arrive at the town of Leninsk near the launch area. The test was awaited with great anticipation, not only because it was the first test of a new

Artillery Marshall Kirill S. Moskalenko who succeeded Nedelin as Commander of the USSR Missile Troops following the latter's death in October 1960. Moskalenko remained in that position until April 1962. Photo Source: Tolubko, V. F., "Nedelin: Perviy Glavkom Strategicheskikh," Molodaya Gvardiya, Moscow, 1979.

missile, but also because the R-16 was to take the role of the first truly operational intercontinental ballistic missile in the Soviet Union. Apart from Yangel, his First Deputy Vasily S. Budnik, Berlin, and Kontsevoy, the following senior engineers also flew in for the launch: B. M. Konoplev, a Deputy to Chief Designer for guidance systems Nikolai A. Pilyugin and G. F. Firsov, a Deputy to Chief Designer Glushko.[16] Scores of other less senior individuals from the major Design Bureaus were also on hand to direct operations.

A State Commission was formed headed by Marshall Nedelin to oversee the preparations leading up to the launch. The Commission met in early October and set the date and time for the first launch: 1700 hours Moscow Time on Sunday, October 23, 1960.[17] The Commission also included leading members of the artillery sector, all whom, like Nedelin had been involved in the development of Soviet post-war ballistic missiles. Among them were Col. Yevgeny I. Ostashov (chief of the test section), Col. Aleksandr I. Nosov (former head of the launch team), Maj.-Gen. Konstantin V. Gerchik (Commander of Tyura-Tam), and Maj.-Gen. Aleksandr G. Mrykin (the First Deputy Commander of the Chief Directorate of Missile Armaments of the Missile Troops). Both Ostashov and Nosov had played very historic roles in the launch of the first R-7 and the first Sputniks in 1957. Maj.-Gen. Mrykin was the most senior 'hands-on' officer for all strategic missile and space launches on behalf of the artillery sector, and reported directly to Marshall Nedelin. He had been involved with the rocketry program since 1945 when he had accompanied hundreds of engineers and artillery men to Soviet-occupied Germany to recover parts of German A-4 missiles. Since then, he had played a key role in the development and operations of all Soviet ballistic missiles. Recently, Mrykin was also involved in launch operations of the Sputnik and Luna launches from Tyura-Tam. According to one account he was:

A strong and lively individual but it is true that some complained about his lack of restraint and stern character. They said that even Sergey Pavlovich Korolyov himself was somewhat afraid of Mrykin.[18]

The leader of the launch team for the first R-16 launch was Col.-Eng. R. M. Grigoryantz replacing Col. Nosov who had been promoted to a position in Moscow. At the last moment Nosov decided to travel to Leninsk to observe the launch, in case his experience came in handy.

There appears to have been considerable pressure on all involved to perform a successful test. Just nine days prior to the scheduled launch, Soviet leader Khrushchev had spoken at the United Nations about the might of the Soviet missile forces, emphasizing that Soviet strategic rockets were being produced "like sausages from a machine."[19] The reality of the situation was, however, quite different. The only missiles the Soviets were producing in large quantities at the time were the R-12 and the R-14, neither of which had the capability to reach the continental United States. The intercontinental R-7A had shown its limitations in a weapons context and was manufactured for the missile forces in only limited quantities. Thus, the pressure was on Yangel and his team to get the R-16 off to a successful start as soon as possible. Parity would have to be achieved in the near future.

The Tragedy

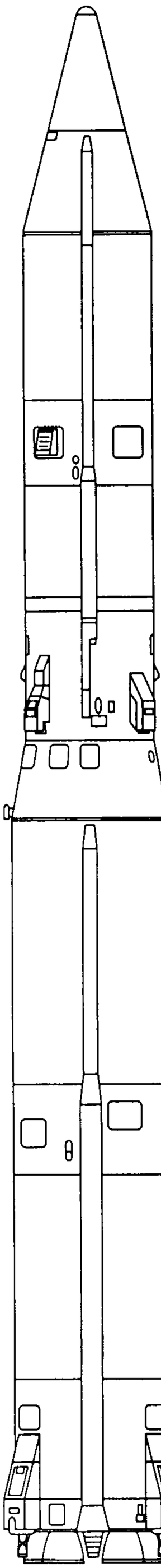
Movement of the R-16 missile (Serial No. LD1-ZT) from the assembly and testing building to the pad at site number 41 began on the morning of October 23. Once the rocket was raised on the pad, Chief Designer Yangel and numerous others walked around the missile trying to direct the whole operation. Reports suggest that the presence of Nedelin and other powerful individuals created a sense of nervousness and tension among the engineers and military personnel involved. Maj.-Gen. Gerchik, the Commander of the Tyura-Tam launch range ordered that chairs and stools be brought from the service building for Marshall Nedelin and the other important guests. They were set up very close to the launch site, so that Nedelin could observe the preparations from a close spot.[20] As the afternoon wore on, activities intensified at the pad. Late in the afternoon, several technical difficulties were encountered by the launch personnel. These included problems with the engine's automatic control system which caused a cut-off valve to open accidentally.[21] This resulted in a fuel leak in the first stage. Some unconfirmed reports suggest that bucket loads of toxic fuel had to be carried from the base of the missile. Other accounts contradict this. Capt. Stanislav N. Pavlov, the launch group chief at the time recalls that:

Chief Designer Mikhail K. Yangel was perhaps the most important of the strategic ballistic missile designers in the 1960s. From 1954 to 1971, as head of the OKB-586, Yangel oversaw the development of the R-12, R-14, R-16, R-26, R-36, RT-20P and the MR UR-100, R-36N and RS-22 missiles. He died on October 25, 1971 on his 60th birthday. Photo Source: Peter Gorin.

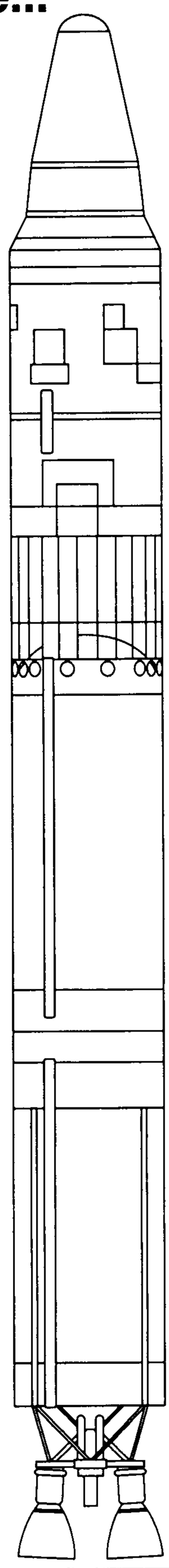
I did not see any fuel spillage...The [fuelling] pipes had joints in them. There was a little dripping from them. We tightened them up. Drops of fuel got on the rubber gloves and made little holes in them. At the time, we didn't attach any importance to that, but later we found out that it was dangerous.[22]

Apparently the leak developed when the protective membranes between the fuel tank and the engine pumps were blown to ensure that the fuel would reach the pumps. A meeting of the State Commission was quickly held to determine the immediate course of action. At Marshall Nedelin's personal recommendation, it was decided to keep the missile fully fuelled and work on the repairs throughout the night.[23] The launch was rescheduled for the evening of the following

The First Heavyweights At A Glance...



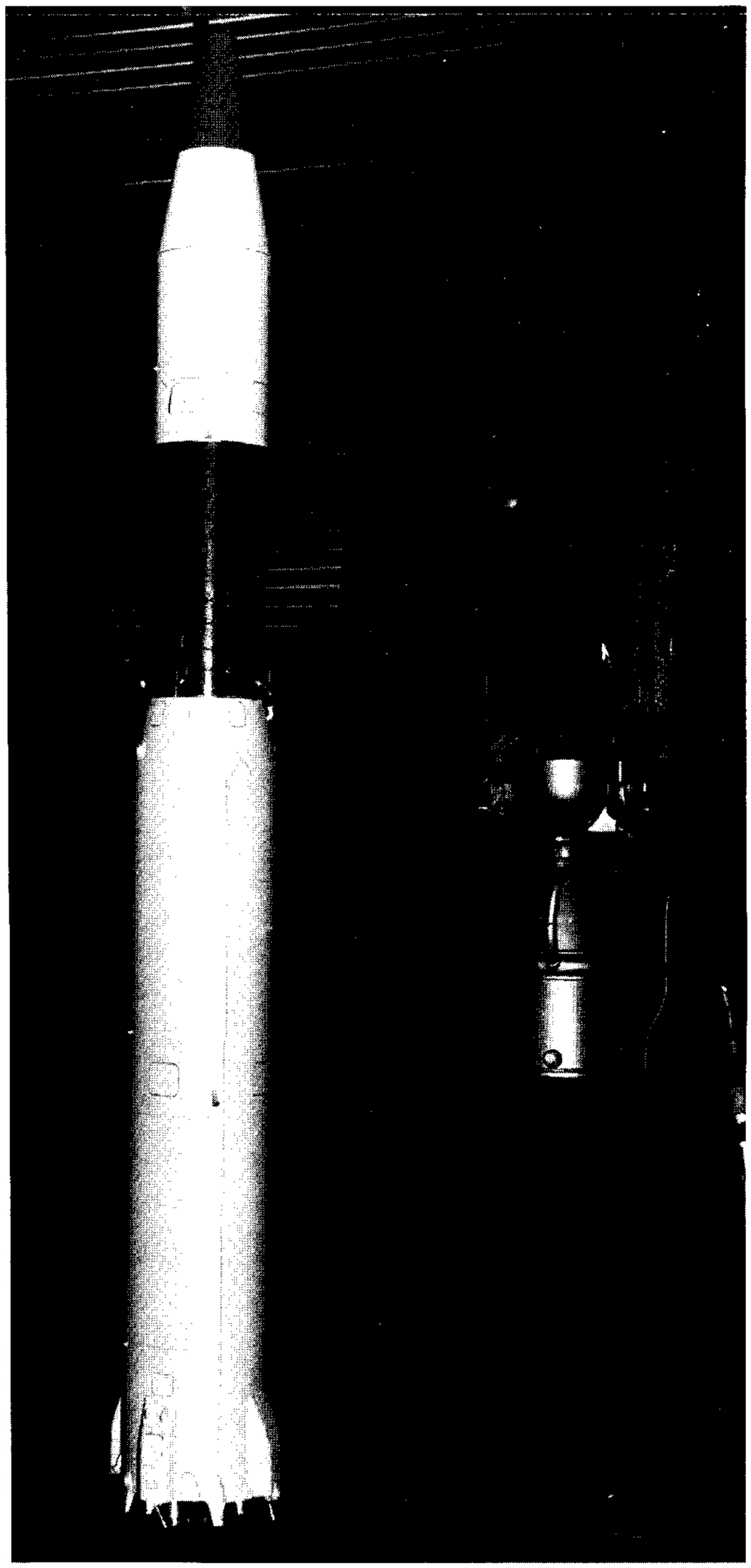
R-16 8K64 SS-7 (U.S. DoD) Saddler (NATO)	**Designation**	Titan II LGM-25C SM-68B
OKB-586 under M.K. Yangel	**Prime Contractor**	Martin Company
1959	**Beginning of Development**	1958
2 February 1961 (Pad explosion on 24 October 1960)	**First Flight**	November 1961
1962	**Beginning of Deployment**	1963
186	**Maximum Number Deployed**	54
65% "Soft" Coffin Sites 35% "Hard" Silo Sites	**Launch Site**	"Hard" Silo Sites
Warhead(s)		
One 5 or 10 MT	**Warhead**	One 9 MT W-33 (inside a Mk-6 RV)
10,500 / 13,000 km	**Range**	15,000 km
1977	**Year of Retirement**	1987
31 meters	**Total Missile Length**	31.39 meters
3 meters	**Missile Diameter**	3.05 meters
140/148 tons	**Total Missile Weight**	149.7 tons
	First Stage Engines	
OKB-456 under V.P. Glushko Three RD-216 derivative (twin chamber)		Aerojet General Two LR-87-AJ-5 (single chamber)
3 x 85 tons	**Sea Level Thrust**	2 x 97.5 tons
255 tons	**Total Launch Thrust**	195 tons
170 seconds	**Burn Time**	155 seconds
4 thrusters	**Steering**	Gimbaled main engines
	Second Stage Engines	
OKB-456 under V.P. Glushko RD-219 (twin chamber)		Aerojet General LR-91-AJ-5 (single chamber)
1 x 90 tons	**Vacuum Thrust**	1 x 45.36 tons
125 seconds	**Burn Time**	180 seconds
4 thrusters	**Steering**	Gimbaled main engine
Nitric Acid & Nitrogen Dioxide	**Oxidizer on Both Stages**	Nitrogen Tetroxide
UDMH	**Fuel on Both Stages**	Aerozine-50



by Peter Gorin

In the late 1950s the Soviet leadership was very aware of the drawbacks of the first Soviet ICBM, the R-7 (SS-6). Unlike its American counterpart—the Atlas, the R-7 was impossible to deploy in large quantities. It was also alarming to the Soviet leaders that the U.S. had been rapidly developing two more ICBMs: Titan-1 and Titan-2. Following its typical "mirror response" pattern, the Soviet government ordered a rush development of similar missiles in 1959. The R-9 ICBM with cryogenic propellant, was seen as the Titan-1 counterbalance and was ordered "just in case." The Soviet counterpart of Titan-2 was R-16 (SS-7). Its development was conducted by the OKB-586 design bureau under Mikhail Yangel.

It was Yangel's first ICBM but his team already had a sufficient experience in designing of smaller missiles with hypergolic propellants. Simultaneously with R-16, OKB-586 was developing an intermediate-range missile known as the R-14 (SS-5). Apparently it was decided that both missiles should have as many common design features as possible. The R-14 was powered by two RD-216 engines, with a thrust of 75 tons each. That engine had an unusual two-chamber configuration. Three similar engines, with an upgraded thrust of 85 tones each, were installed on the R-16 first stage. The designations of these engines are not known, but it might have been "RD-217." The steering vanes, typical for R-14, were replaced by four small liquid propellant thrusters. The R-16 second stage was powered by another derivative of the same engine called RD-219. It was adopted for optimal use in the vacuum of space and was supplemented by another four steering thrusters. All engines were developed by the OKB-456, under Valentin Glushko.



The extensive use of existing technology considerably shortened the R-16 design period. The missile was ready for its first flight far ahead of Titan-2, which began development in 1958. Despite the "Nedelin Disaster" and later malfunctions, the missile entered service in 1962, again ahead of Titan-2. In accordance with the Soviet tradition of that time, R-16 was deployed in two major configurations: one involving a "light-weight" warhead (5 MT) and another with a "heavy" warhead (10 MT). The latter model had a shorter range. In 1961 Mikhail Yangel was awarded his second highest Soviet state award for the R-16 development.

The R-16 initially was designed for open unprotected (so-called "soft") launch pads. On May 30, 1960, the USSR adopted a decision to develop "hard" launch pads (underground silos) for all of its newest missiles. In 1963 the deployment of the new R-16U missile began in the silos. That rocket had a longer range even with the "heavy" warhead. For about fifteen years R-16 was a backbone of the Soviet Strategic Rocket Forces. A total of 186 missiles were deployed by 1967, and about 35% of them in silos. From 1969–1977 the R-16s were gradually replaced by ICBMs of the second generation.

Unlike many other older Soviet missiles, the R-16 has never been publicly displayed. Only low-quality footage of an R-16U being launched from a silo, was released in the USSR about twenty years ago. Later, a model of the missile and a full-scale mockup of the second stage engine compartment were displayed at the Soviet Armed Forces Museum in Moscow. A picture of that model (shown above) taken by the author in 1984, clearly shows four of six main nozzles on the first stage. A gimbaled steering thruster on the second stage is visible in the background. The second stage mock-up (not shown in the picture) displays the RD-219 engine mount. That exposition and the released data on the RD-216 and 219 engines helped resolve some of the R-16 design features.

Immediately after the R-16 achieved operational status, the OKB-586 began development of an improved version of the missile. The modernized variants utilized the same engines along with new avionics and larger tankage. This is how the R-36 (SS-9)—one of the most fearsome Soviet ICBMs was born. ●

Data: Peter Gorin, Daniel James Gauthier, Asif Siddiqi Illustrations: Daniel James Gauthier, FBIS

day, October 24. In an ironic twist, Nedelin had just arrived from the Kapustin Yar State Central Range where he was to have witnessed a launch of the shorter range R-14 missile. Due to a malfunction, the launch of the R-14 had to be postponed, and it was decided to drain the missile of its propellants before proceeding with repairs. The standards were not applied in the case of the more powerful R-16 missile, and many have suggested that Nedelin was under severe pressure to get the missile off from Communist Party leaders such as Khrushchev, Kozlov, and Serbin, and thus capitulated to them by calling for repairs in a fully fuelled state. Ground crews carefully removed the hatches on the lower portion of the first stage, and soon began resoldering the missile's joints in a serious and obvious violation of the safety rules.[24] The repair crews worked throughout the night under search lights knowing full well that the missile could only be kept fuelled for a maximum of 48 hours before the launch would have to postponed for later in the week. The pressure on them was intense.

By the morning, the original repairs were finished, but anxiety arose once more when a second smaller fuel leak was detected. The State Commission was again convened and based upon recommendations from engineers and ballistics technicians, Nedelin decided to allow the launch to proceed as planned for that evening. As the sunlight waned on the test range, Nedelin sat himself down at one of the chairs and reviewed two platoons, graduates of the F. E. Dzerzhinsky Military Academy who were to be involved in future launch operations of the missile forces. The commanders of the units gave their reports to Nedelin, after which Nedelin "dressed them down for their slipshod formation" and then gave a short speech:

You have come here for the first launch of an intercontinental ballistic missile that uses new fuel that is extremely promising for operation in combat units. Your presence is an honor for you. You are the first to get experience in the preparations for the launch of this newest missile under real conditions. Therefore, be attentive at your work stations. As much as possible, develop the practical skills that will be needed in your own unit.[25]

Nedelin dismissed the units just one hour prior to the scheduled launch and sat back down on his chair approximately 17 meters from the R-16. The launch was scheduled for 1915 hours Moscow Time.

When the 30 minute mark was announced, all extraneous personnel including the emergency rescue services were asked to leave the pad area. Unbelievably enough there were still about 200 individuals, including Nedelin, who were still at very close range to the rocket. They included numerous engineers from the Yangel Design Bureau, artillery officers and soldiers, and several representatives from the government. Apparently, Nedelin's advisors had recommended that he withdraw to a bunker at that point, but he had reportedly answered, "What's there to be afraid of? Aren't I an officer?"[26] At this point, an apparently unexpected delay in the launch was announced, followed by a second delay.[27] Maj.-Gen. Mrykin who was standing near Nedelin, in a fit of nervousness approached Chief Designer Yangel and said:

"This is it, Mikhail Kuzmich, I am quitting smoking, let us go off to the side and smoke a last cigarette." [28]

Thus Mrykin and Yangel walked over to join Col. Aleksandr S. Matryonin, the chief of the combined rocket section in a bunker at the command post that was safe for smoking. Marshall Nedelin himself stood up and began to discuss the situation with L. A. Grishin, a top representative from the defense industry, walking between the ramp and the rocket, about 10 to 15 meters from the missile.

At exactly 1845 hours Moscow Time on October 24, 1960, while performing operations for bringing the programmed current distributor in the autonomous control system to its initial setting, a technician sent a signal to the R-16 missile. The cable's distribution system, however, malfunctioned and instead sent a spurious command to the engine of the second stage to fire.[29] As soon as the engine fired, a huge fireball engulfed the upper part of the missile. The exhaust from the second stage ignited the tanks of the first stage, exponentially increasing the potency of the blast, resulting in a massive fire explosion. At the same time, a motion picture camera that was to have taken a film of the launch was activated and recorded the tragic scene in gory detail. The technicians who were closest to the missile were instantly engulfed in the fireball and burned up in seconds. Those on the ground made desperate attempts to escape the fire and acid, only to be hit by the wave of fire that expanded like a circle around the area. V. Kukushkin of the OKB-586, who was standing close to Nedelin recalls that:

The air wave from the engine that had fired pressed the marshall [Nedelin] against the concrete overhang of the roof near which he was sitting. The flame, apparently reached him there. The explosion lifted me up and dragged me about 30 meters along the sidewalk.[30]

The initial shock wave from the missile saved Kukushkin's life by lifting him far enough from the fireball for him to run away with his life (although he suffered severe burns). Soon the rocket broke in half and fell on the pad, crushing anyone who might have still been left alive. At this point, the fire and the heat increased in intensity as all the propellants ignited in a crescendo. Some people were simply engulfed in the fire, others who managed to run completely burned, succumbed to the toxic gases within minutes. Some technicians remained hanging from their harnesses from special cranes as their bodies burned. Captain Pavlov, the launch group chief was one of the few lucky ones who were thrown by the initial shock wave and managed to run through the flames to safety. He was so badly burned that physicians had to cut off his clothing and boots which had become attached to his skin, while his jacket was burned to ashes.[31] The representative from the industry, Grishin, who had been standing next to Nedelin, had managed to jump over a high railing, run across the molten tarmac, jumping to the high gate of the ramp from a height of 3.5 meters, breaking both legs in the process to reach safety. Tragically, he succumbed to his burns soon after he was taken to the hospital. As the temperature raged to around 3,000 degrees, people just simply melted in the firestorm, many being reduced to ashes.

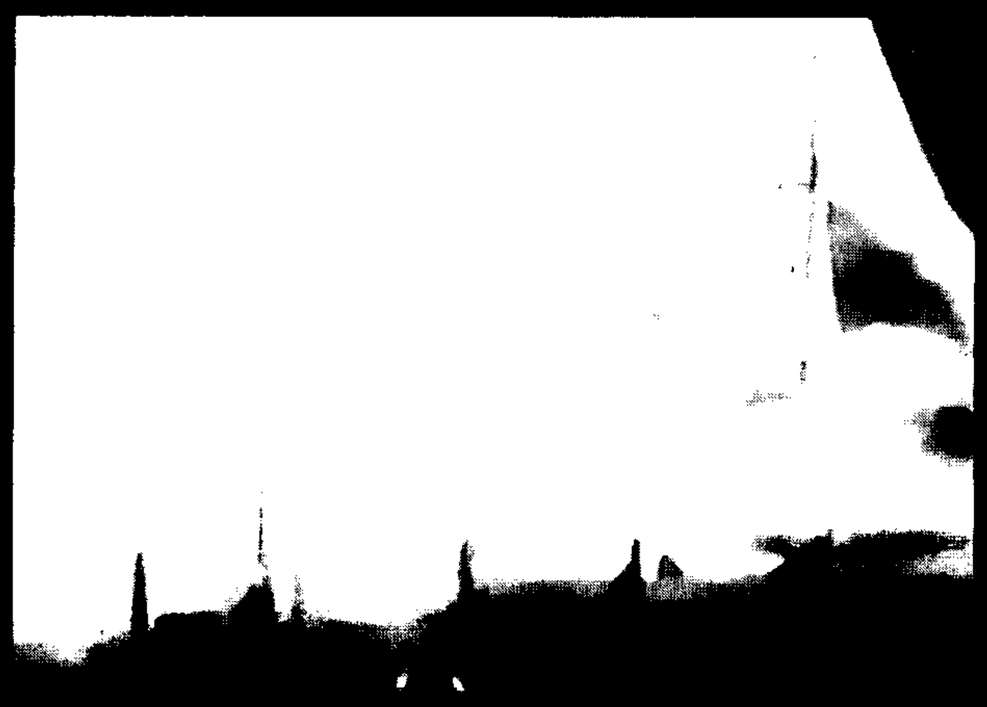
Those in the bunkers around the launch site remained safe in their protective cocoons. Maj.-Gen. Mrykin, who had saved his and Chief Designer Yangel's lives with his last cigarette, immediately tried to take some semblance of control of the situation. He quickly ordered Senior-Lt. Boris I. Klimov, the chief of the telemetry laboratory to form a group of 30 soldiers, called in from elsewhere at Tyura-Tam to report to him immediately. Mrykin issued an order to "find everything that could have remained."[32] Klimov recalls his first impressions upon entering the launch area:

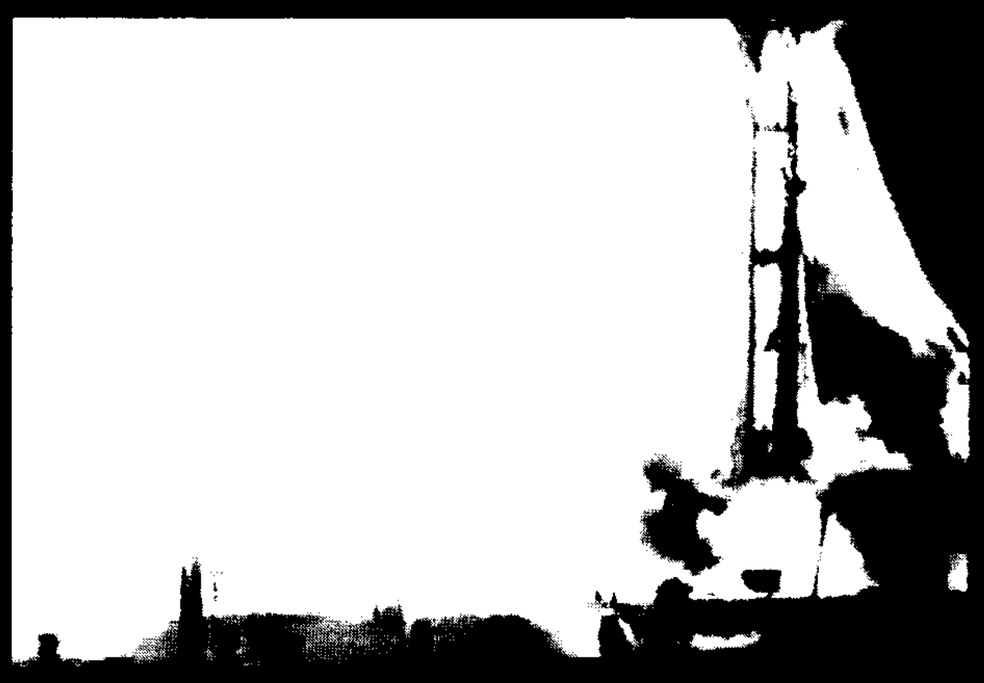
Driving up to the pad, I saw that we would not be able to manage without gas masks. But even with them on, it was impossible to work...The dead were not identified visually, but from typical personal belongings, like keys from apartments.[33]

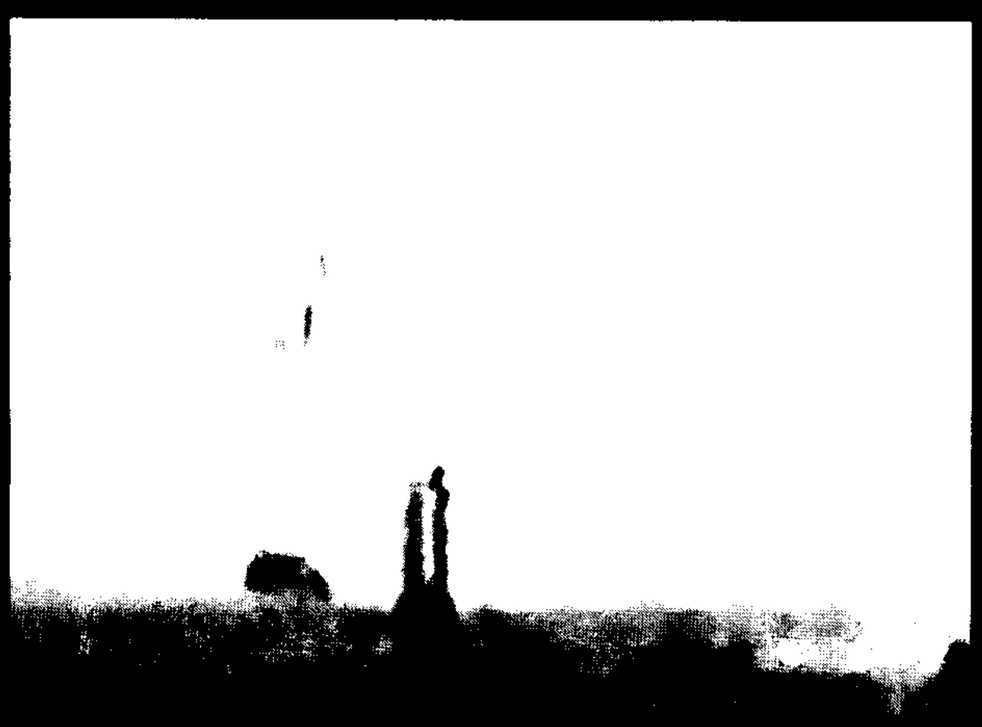
Another officer from the team remembers that:

They carried the dead off the site and laid them near the medical unit. All of the corpses were in identical and somewhat doubled up poses and all were without clothes or scalps. It was impossible to identify anyone. Under the light of the moon, they seemed to be the color of ivory.[34]

As the scene at the area quietened down, emergency medical crews were sent to scour through what remained. Scores of individuals with severe burns were taken to nearby hospitals in Tyura-Tam and Leninsk. Work was both dangerous and tiring for the crews as they worked throughout the night. By morning, the magnitude of the disaster became apparent. Among those from the Yangel Design Bureau alone, scores of designers and engineers had been killed, effectively decimating the organization. Dozens of young soldiers on their first assignment as







No known still photos exist of the accident but a motion picture camera that was to have taken a film of the launch was accidently activated and recorded the entire tragic scene in gory detail. These stills from that footage show workers running for their lives from the intense fireball. As temperatures rose to 3,000 degrees, many were instantly engulfed in flames and consumed in seconds.

*Photos were obtained from the film "Soviet Space The Secret Designer" and are used by permission from Rudy, Inc.