

**SPACE SCIENCE AND TECHNOLOGY SERIES**



# **Yuzhnoye Launchers and Satellites**

**Christian Lardier**

**ISTE**

**WILEY**





## Yuzhnoye Launchers and Satellites





*Series Editor*  
*Jean-Luc Lefebvre*

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Christian Lardier

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**WILEY**

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## Foreword

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The start of rocket building in Ukraine can be considered as May 9, 1951. On that day, USSR Council of Ministers Decree No. 1528-7680 “On the Transfer of the Dnepropetrovsk Automobile Plant and the Dnepropetrovsk Tire Plant in Construction of the USSR Ministry of Armaments, and their Combining into Dnepropetrovsk Machine-Building Plant No. 586” was issued. On June 1, 1951, USSR Council of Ministers Decree No. 1852-885 “On the Organization of the Serial Production of R-1 Missiles”, developed by S.P. Korolev, was issued.

The first batch of R-1 rockets was sent to missile troops in November 1952 and confirmed by successful launches at the Kapustin Yar Range.

In February 1953, USSR Council of Ministers Decree No. 442-212 “On the Plan for Work to Develop Long-Range Rockets in 1953–1955” was issued. The Prime Contractor of the R-12 long-range rocket was approved: Plant No. 586 of the USSR Ministry of Armaments and the Design Office of Plant No. 586 (Main Designer: V.S. Budnik; Director of Plant No. 586: L.V. Smirnov) with the participation of NII-88 – Director M.K. Yangel.

This document was a plan for the creation of a new OKB based on serial production KB No. 586, which was implemented on April 10, 1954. On July 9, 1954, OKB-586 was headed by M.K. Yangel, and V.S. Budnik was appointed First Deputy. The world’s first missile conglomerate, KB Yuzhnoye + YuzhMashzavod (YuMZ), appeared, which began to produce ballistic missiles “like sausages”, to quote the country’s then-Head, N.S. Khrushchev. Throughout the years of collaboration between the KB and the Southern Machine-Building Plant, more than a dozen military missile systems and space launchers were created and commissioned. The General Designer, M.K. Yangel, and the Director General of the Southern Machine-Building Plant, A.M. Makarov, were associated with the creation

of military and scientific satellites. The first satellites for India were produced at YuMZ.

Work began on the Interkosmos program, including with France's science and space industry. More than 500 devices for various purposes were manufactured and launched under the YuMZ brand. The emergence of such a rocket-cosmos complex in Ukraine gave impetus to the development of companies – suppliers of special materials, separate key devices for rockets and satellites at Kiev, Kharkov, Chernigov, Lvov and Zaporozhye. YuzhMash and KB Yuzhnoye also took part in the creation of a rocket for flight to the Moon; this was the special “Block-E”. The role of the Southern grouping in the creation of the “Energia-Buran” reusable system was significant. The accelerators for the Energia launcher were created in Dnipro, based on the first stage of the “Zenit” launcher.

I believe readers will be interested to learn of many new, and until now unknown, details concerning the Southern rocket-building consortium in Ukraine, and will wish to pay tribute to those brilliant designers and workers who created this unique technique.

Alekseyev Yury SERGEYEVICH  
YuzhMash (1972 to 2004), Director General (1992 to 2004)  
Director of the Ukrainian Space Agency (2005 to 2014)  
Hero of Ukraine (2002)  
Academician of the International Academy of Astronautics

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## Introduction

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In the USSR, three major space companies built the majority of rockets and satellites from 1957: Sergei Korolev's OKB-1, Vladimir Chelomei's OKB-52 and Mikhail Yangel's OKB-586. These gave rise to subsidiaries such as TsSKB-Progress, ISS Reshetnev, NPO Lavochkin, etc.

OKB-1/RKK Energia developed the famous R-7 rocket, a.k.a Semiorka, which has been launched in more than 1,950 units. The best known version is the Soyuz rocket, which was marketed by Starsem from 1996, then by Glavkosmos from 2018. Soyuz was launched from Guyana between October 2011 and February 2022 (27 flights). In 2011, together with Stefan Barenyski, I published a book on this launcher, *The Two Lives of Soyuz*, recounting the history of OKB-1, the launcher, and how it was marketed.

OKB-52/NPO Mash developed the famous UR-500 rocket, a.k.a Proton, which has been launched in more than 420 units. The Fili subsidiary (OKB-23 Salyut and Plant No. 23 Khrushchev) became the Khrushchev Center in 1992. This formed ILS (International Launch Services) with Lockheed Martin in 1995 to market Proton (97 flights), which was the main competitor of the European Ariane rocket before being replaced by Space X's Falcon 9 from 2014. In 2016, together with Stefan Barenyski, I published a book on *The Proton Launcher: History and Developments*, which recounted the history of OKB-52, the launcher, and how it was marketed.

OKB-586/KB Yuzhnoye, for its part, has developed a large number of intermediate-range (IRBM) and intercontinental (ICBM) strategic missiles, as well as their space versions: 8K63/R-12/Kosmos, 8K64/R-16, 8K65/R-14/Kosmos-3, 8K66/R-26, 8K67/R-36/Tsiklon-2, 11K68/Tsiklon-3, R-46, 8K68/R-56, 15A14/R-36M, 15A15/MR-UR-100, 15A18/R-36M2/Dnipro. It also developed the 11K77/Zenit-2 launcher and the Block-A (first stage) of the 11K25/Energia super-rocket. In the field of satellites, it first developed the small DS satellites (D for



Dnepropetrovsk) of the Kosmos program for the Academy of Sciences and the Ministry of Defense (DS-A1, DS-MG, DS-MT, DS-MO, DS-K8, DS-U1, -U2, -U3, -U4, -U5, etc.), then calibration satellites DS-P1, Taifun, Duga-K and Koltso for the ground-based radars, Tselina electronic monitoring satellites, Tyulpan targets for anti-satellite satellites, and satellites of the type AUOS, Interkosmos, Okean, etc. From 1991 to 2019, Yuzhnoye and YuzhMash produced and launched 65 Zenit rockets, 22 Dnipro rockets, 14 Antares, 19 Vega fourth-stage engines and 14 satellites. Marketing in the West was handled by Kosmotras, Sea Launch and Land Launch.

SKB-586/OKB-586 was headed by V.S. Budnik in 1951, M.K. Yangel in 1954, V.F. Utkin in 1971, S.N. Konyukhov in 1990, A.V. Degtyarev in 2010 and A.P. Kushnarev in 2021. On October 25, 2021, we celebrated the 110-year anniversary of the birth of Yangel, a designer of the same significance as Korolev and Chelomei. Plant No. 586, for its part, was headed by L.V. Smirnov in 1952, A.A. Makarov in 1961, L.D. Kuchma in 1986, Yu. S. Alekseyev in 1992, V.A. Shegol in 2005 and S.N. Voit in 2014. On September 12, 2021, we celebrated the 115-year anniversary of the birth of Makarov. In 1966, the OKB became Yuzhnoye and the plant became YuzhMash. In 1991, Yuzhnoye became KB Pivdennyi, from the name of M.K. Yangel.

This book recounts the history of this third industrial pillar of Soviet and Ukrainian cosmonautics. It is organized around two periods: the first relates to the Soviet period between 1951 and 1991 (40 years) and the second relates to the period of independent Ukraine between 1991 and 2021 (30 years). On February 24, 2022, the Russo-Ukrainian War began.

My thanks go to Stanislav Konyukhov†, Aleksandr Degtyarev†, Oleg Ventskovskiy, Yury Moshnenko†, who guided me during my visit to Dnipro in June 2005, Aleksandr Kashanov, who guided me during my visit to Dnipro in November 2015, Yury Alekseyev, Eduard Kuznetsov, Vladimir Priskyakov† and Vladimir Platonov, as well as Jim Maser, Robert Peckham, Kjell Karlsen, Paula Korn of Sea Launch, Igor Marinin and Igor Afanaseyev of Novosti Kosmonavtiki for permission to publish certain photos, Jacob Terweij and Arsen Dzodzayev for certain photos, Mikhail Pervov of Stolichnaya Entsyclopedia, Aleksandr Zheleznyakov, Valery Kuprianov, Irina Isayeva and Nicolas Pillet for the proofreading of my manuscript, and others for their help.

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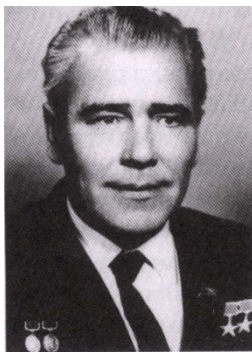
† Deceased.

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# Mikhail Yangel: The Father of Yuzhnoye

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## 1.1. Mikhail Kuzmich Yangel

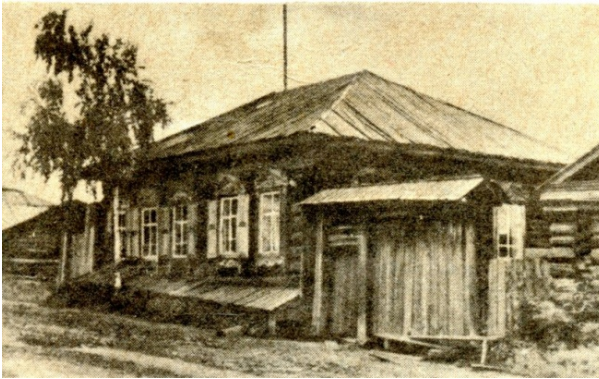


**Figure 1.1.** *Mikhail Kuzmich Yangel (source: rights reserved)*

Mikhail Kuzmich Yangel was born on October 25, 1911 (Julian calendar) or November 7, 1911 (Gregorian calendar) in the village of Zyryanova in the Nizhny-Ilimskiy region, near Irkutsk (Siberia). His parents, Kuzma Lavrentiyevich and Anna Pavlovna, were peasants. They had 12 children (eight boys and four girls): Nikolai (1900–1962, made his career in the army), Kirill (1901, died at a few months old), Aleksandr (1903–1974, Major General of the NKVD), Konstantin (1907–1938, educated at the School of Mines, arrested and executed in 1938), Nadezhda (1907–1932), Mikhail (1911–1971), Galina (1913–1945), Zoya (1915–1923), Pavel (1917–1970), Georgy (1921–1972), Valentina (1923–?) and Yakov (1926–1988).

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For a color version of all figures in this chapter, see [www.iste.co.uk/lardier/yuzhnoye.zip](http://www.iste.co.uk/lardier/yuzhnoye.zip).



**Figure 1.2.** *The Yangel house in Zyryanova (source: rights reserved)*

Mikhail joined the Komsomol (Communist youth organization) in 1925. The following year, at the age of 15, he moved to Moscow to join his brother Konstantin. He attended the Krasnoarmeysk Textile Factory School near Moscow, and then worked in the factory of a workshop. In July 1931, he joined the Communist Party of the Soviet Union (CPSU). In September, he joined the newly established Moscow Aviation Institute (MAI), but we do not know whether he had a passion for aviation prior to joining the Institute.



**Figure 1.3.** *Yangel in the United States in 1938 (source: rights reserved)*

He soon became a member of the Party Committee and then Secretary of the Komsomol Committee of the Institute. There he attended the courses of the famous Aircraft Designer, N.N. Polikarpov. In September 1935, he became a Second-Category Designer at the Polikarpov Design Bureau (OKB) to complete his

thesis project, “High-Altitude Fighter with a Pressurized Cabin”. After graduating in January 1937, he joined the Wings Brigade of the OKB where he worked on modifications to the I-15 and I-16 fighters, notably the I-153 Chaika, which were widely used during the Spanish War.

From February to September 1938, he was part of a Soviet delegation that traveled to the United States within the framework of the US-Soviet trade agreements. He resided on 5th Avenue in New York and visited several aviation plants in Chicago (Boeing), Los Angeles (Lockheed), Santa Monica (Douglas), San Diego (Consolidated Vultee Aircraft Corp), etc. On his return, in November, he was appointed Deputy to Polikarpov.

On May 23, 1939, he married Irina Viktorovna Strazheva (1915–1995) who had been studying at MAI since 1935. In 1940, she became an engineer at the Flight Research Institute (LII). A specialist in aerodynamics, she taught at MAI and went on to become a Doctor of Technical Sciences. She bore Mikhail two children: Ludmilla (1940–2021) and Aleksandr (1942–1989). They both graduated from MAI, Aleksandr to work as a journalist, and Ludmilla to become a Doctor of Technical Sciences and a professor.



**Figure 1.4.** *Wedding to Irina in 1939*  
(source: rights reserved)

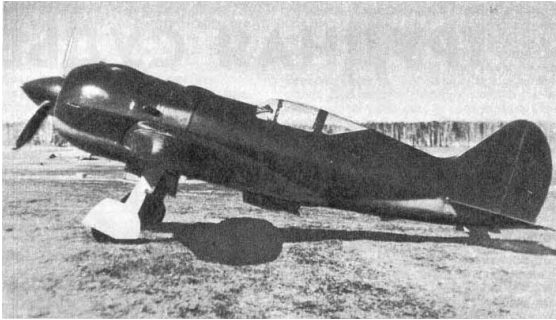
After his wedding, Yangel then moved to Gorky Plant No. 21 to organize the serial production of the I-180 fighter. It was onboard this plane that the famous pilot V.P. Chkalov was killed on December 15, 1938. In April 1940, Yangel returned to

become Lead Engineer of the heavy escort fighter TIS (A). It was an aircraft of 8.9 t max on take-off, equipped with two AM-37 engines. It was set to be produced by Moscow Plant No. 51, and in July he was appointed Deputy Plant Director and Lead Engineer at the OKB. However, the war then began on June 22, 1941. The first flight of the TIS (A) was conducted by the test pilot G.M. Shyanov on August 30th. He then organized the evacuation of the plant in Novosibirsk in November. On June 13, 1942, the TIS (A) was entrusted to A.V. Potopalov and Yangel returned to Moscow. He became Head of an assembly shop in a plant, then Deputy Head of the flight test station on December 5th. On January 16, 1943, he rejoined the Polikarpov OKB. Yangel then organized the repatriation of the plant and the serial production of the I-185 fighter. However, on April 5th, the pilot V.A. Stepanchenok died during a test flight of this aircraft, which ultimately did not get serially produced.



**Figure 1.5.** *The Yangel family (source: rights reserved)*

In February 1944, Yangel returned to Moscow and the following month, he became Deputy Main Engineer at OKB-155 of A.I. Mikoyan for nine months. Shortly thereafter, on July 30th, Polikarpov died of stomach cancer. His OKB-51 was then entrusted to V.N. Chelomei for the development of the Soviet V-1: the 10Kh missile. In February 1953, the OKB was withdrawn from him and was entrusted to Mikoyan. It became the subsidiary for winged rockets, headed by M.I. Gurevich. Stalin died on March 5th. In October, the subsidiary was withdrawn from Mikoyan to merge with OKB-1 of P.O. Sukhoi. This OKB had been created to produce a model of the American F-86 Sabre from a copy recovered in Korea in May 1952. It was initially headed by V.V. Kondratiyev, and then by Sukhoi from May 1953. On January 15, 1954, it formed the new OKB-51 to develop the S-1 (swept wing) and T-1 (delta wing) fighters.



**Figure 1.6.** *The I-185 aircraft of 1943 (source: rights reserved)*

In January 1945, Yangel became Lead Engineer of the VB-109 aircraft in OKB-482 of V.M. Myasishchev in Moscow (for 1 year). But the OKB closed. In January 1946, he became Lead Engineer in a Sector of the Ministry of Aviation Industry for (two years), which was working on a new technique. Indeed, this was the beginning of jet aviation. From early 1948 to March 1950, he studied at the Academy of Aviation Industry (for two years) in Moscow. His degree was in the calculation of a fighter wing. At the Academy, he met S.O. Okhapkin, who, having graduated from MAI in 1938, had worked in the OKBs of Tupolev, Myasishchev and Ilyushin. They were the only two of their year group to enter the rocket industry. On April 12, 1950, Yangel became Head of Sector No. 5 (Guidance Systems) at OKB-1 of NII-88 headed by Sergei Korolev. He replaced Boris Chertok, who became his Deputy (Chertok was Jewish and victim of Stalinist cosmopolitanism) because Yangel had no experience with guidance systems and rockets. Korolev explained to Chertok that he would deal directly with him because Yangel was to be with them for a long time. Okhapkin was Head of the Strength Section.

On March 24, 1951, Myasishchev's OKB reopened: it became OKB-23, in charge of building a strategic jet bomber (aircraft 25, M4). He requested the return of Yangel and Okhapkin to his Design Bureau. But ultimately, they stayed with Korolev.

On May 9, 1951, production of the R-1 was entrusted to Plant No. 586 in Dnepropetrovsk (Ukraine). A team from OKB-1, headed by V.S. Budnik, Head of Sector No. 4 (Construction), visited the site, where he created a Serial Production Design Bureau (SKB). Budnik was then replaced by Okhapkin.

On July 31, 1951, Yangel was appointed Korolev's Deputy Chief Designer. At this time, the OKB was developing the R-5 and R-11 ballistic missiles. The first was oxygen/kerosene (non-storable) and the second was nitric acid/kerosene (storable).



**Figure 1.7. Korolev's R-11 missile**  
(source: rights reserved)

On March 20, 1952, three rocket-engine Design Bureaus were formed: OKB-1 of L.S. Dushkin at NII-1, OKB-2 of A.M. Isayev and OKB-3 of D.D. Sevruck at NII-88.

On May 16, 1952, Yangel took over the management of NII-88, replacing K.N. Rudnev, who became Deputy Minister of Armaments. He then rose above Korolev, having only been at the Institute for two years. But he was a communist who was supported by Minister D.F. Ustinov while Korolev was imprisoned in 1938–1944 and was not yet at the CPSU (he was not until one year later). Yangel's predecessors were Directors of arms plants: L.R. Gonor, Director in 1946–1950, had headed Gun Plants (Barricade, UralMash and Bolshevik), while K.N. Rudnev, Director in 1950–1952, had headed TsKB-14 in Tula and NII-61 in Klimovsk (Firearms).

Yangel headed NII-88 for 18 months. But during this period, important Decree No. 443-213ss: "On the Plan of Scientific-Research Work on Long-Range Rockets in 1953–1955" was issued by Stalin on February 13, 1953, providing for the creation of an intercontinental missile.

On October 30, 1953, Yangel became Main Engineer at NII-88 following his replacement by A.S. Spiridonov. The latter had been Main Engineer at the Institute in 1948–1949, then Head of the 7th Glavka for six months, then Head of the 6th Glavka of the Ministry in 1949–1953. Yangel's predecessor was M.S. Ryazanskyi was Chief Designer at NII-885 in May 1946, Main Engineer at NII-88 in January 1951, then Head of the 7th Glavka of the Ministry in June 1952.

In order to develop storable propellant rockets and create a competitor to Korolev, the government decided to form a new OKB in Dnepropetrovsk. Thus, the Budnik SKB was transformed into OKB-586 by Decree No. 674-292 of April 10,



1954. And on July 9th, Yangel was appointed its Head and its Chief Designer. This marked the end of Korolev's monopoly. Yangel directed this organization for 17 years. He was twice awarded the Hero of Socialist Labor Medal in July 1959 for R-12, and in June 1961 for R-14, the Lenin Prize in April 1960 for R-12, the State Prize in 1967 for R-36, four "Orders of Lenin" in 1956 (R-5M), in 1959 (Hero), in October 1961 for his 50 years and in 1969 (8K69/R-36Orb), the Order of the October Revolution in April 1971 and the Korolev Gold Medal of the Academy of Sciences in 1970.



**Figure 1.8.** *Awarding of the Hero of Socialist Labor Medal in June 1961: from left to right, V.P. Finogenov,?, K.N. Rudnev, V.P. Glushko, V.I. Kuznetsov, D.F. Ustinov, L.I. Brezhnev, M.K. Yangel, M.P. Geogradze, N.A. Pilyugin,? (source: rights reserved)*

He was a Doctor of Technical Sciences in 1960, Professor at the University of Dnepropetrovsk, Academician of Ukraine in 1961, then Academician of USSR in 1966. He was elected Deputy of the city of Kaliningrad (now Korolev) in 1952–1954, then Deputy to the Supreme Soviet in 1966–1971. Lastly, he was a candidate for the CPSU Central Committee at the 1966 Congress, but was not elected as a Member of the Congress of 1971 (March 30 to April 9, 1971). He died of a fifth heart attack on his 60th birthday, October 25, 1971. Like Yangel, Korolev also died at the age of 60, on January 14, 1966 during surgery that went wrong. He is buried in Novodevichy Cemetery in Moscow. Busts of Yangel are found in his native village (Siberia), at his company based in Dnepropetrovsk, in Baikonur and in Plesetsk.





**Figure 1.9.** Monuments to Yangel: a) native village in Siberia; b) OKB-586/Yuzhnoye; c) Yangel Street in Dnipro; d) in Leninsk-Baikonur; e) Zone No. 43; and f) in Mirny-Plesetsk (source: rights reserved)

## 1.2. The Dnepropetrovsk Plant

For serial production of the 8A11/R-1, it was first decided to use Artillery Plant No. 385 of Zlatust in the Urals (Decree of December 14, 1947). It was headed by N.P. Poletayev (1905–1990). In 1949, Korolev sent his Deputy, A.Y. Sherbakov (1901–1978) to open a Production Bureau that studied the 50R and 50RA versions. But by October 1950, nothing had yet come to fruition and production of the R-1

was transferred elsewhere. For its part, Plant No. 385 made Isayev engines in 1951, the 8B51 missile from Sevruk in 1952, then the R-11 from Korolev from 1953. The second site studied was in Kiev, but Minister Ustinov refused to place such a strategic plant in the capital of Ukraine. Lastly, the YuzhMash Plant No. 586 in Dnepropetrovsk was chosen. It was an automobile plant (DAZ) that became the largest rocket production plant in the world.

This plant was established on July 21, 1944 after the withdrawal of the Germans. Initially, it produced Gorky (GAZ) automobile plant vehicles. In August, the Minister of Medium Machine Building<sup>1</sup> S.A. Akopov appointed V.A. Grachev as Chief Designer. In 1950, G.M. Grigoriyev was appointed Plant Director and the Head of Production was A.M. Makarov. The Plant was then awarded a Stalin Prize (Grigoriyev, Grachev, etc.). When Ustinov decided to move the plant into rocket production, Minister Akopov opposed it. But Stalin said: “if we have rockets, we will make trucks, but if we do not have rockets, we will no longer have trucks”.

On May 9, 1951, Decree No. 1528-768 “On the Merging of DAZ of the Ministry of Automobile and Tractor Industry and the Tire Plant of the Ministry of Chemical Industry into Machine-Building Plant No. 586 of the Ministry of Armaments” was signed by the Government. It was made secret and its address was “P.O. Box No. 186”. At that time, it had more than 8,700 employees. The next day, the Ministry issued Order No. 312ss appointing an Implementation Commission: this comprised six people from the 7th Glavka (Rockets), four from NII-88 (S.N. Kurdin, V.S. Budnik, A.V. Soloviyev and P.F. Serdyuk) and one from OKB-456 (F.G. Potekhin). Then Order No. 380 of June 1, 1951 established the organization of the serial production of R-1. Initially, the objective was to make 70 units in 1951, 230 in 1952, 700 in 1953, then 2,500 from 1954. The first R-1 of Dnepropetrovsk flew in November 1952. Nikita Khrushchev came to say that it produced rockets “like sausages”.

On November 30, 1951, an order from Ustinov decided on the organization of the serial production of 8J38/R-2 with its RD-101 engine at Plant No. 586. On August 31, 1952, the order was given to produce the Lavochkin V-303 surface-to-air missile (S-25 Berkut system) with its S09-29 engine. On November 13, 1954, the Central Committee indicated that only 61% of R-1 production had been achieved and only 39% of R-2 production. In 1955, the production of R-1 was replaced by that of 8K51/R-5 and 8K51M/R-5M. On June 20, 1955, the production plan for 1956–1960 aimed for the production of 330 R-5Ms (50 in 1956, 80 in 1957, 100 in

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<sup>1</sup> Became the Ministry of Automobile Industry on February 17, 1946, then of Automobile and Tractor Industry on August 23, 1947.

1958 and 100 in 1959). In addition, a second plant in the Urals had to produce 1,000 rockets/year from 1961, but this project was abandoned. On April 20, 1956, decorations were awarded for R-5M: M.K. Yangel and L.L. Yagdzhiyev were awarded the Order of Lenin; V.S. Budnik, I.I. Ivanov, F.F. Falunin, L.V. Smirnov, A.M. Makarov and N.D. Khokhlov were awarded the Order of the Red Banner of Labor. In 1968, 628 rockets were deployed in regiments. Lastly, Plant No. 586 supplied OKB-1 with R-5s for geophysical launches from 1958 to 1971.

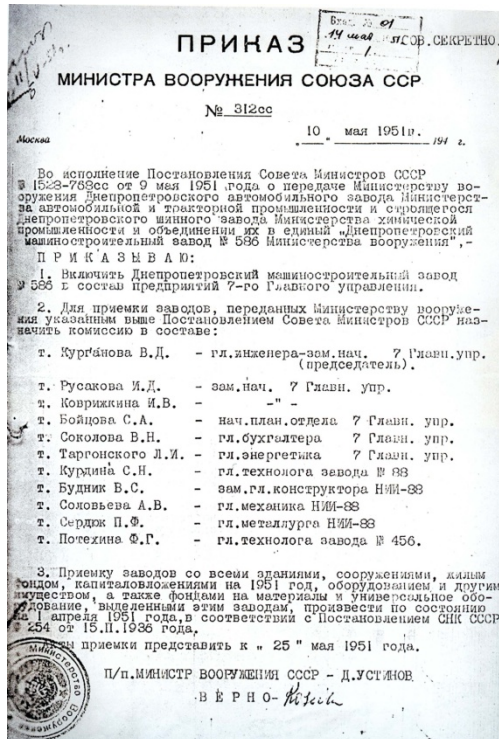
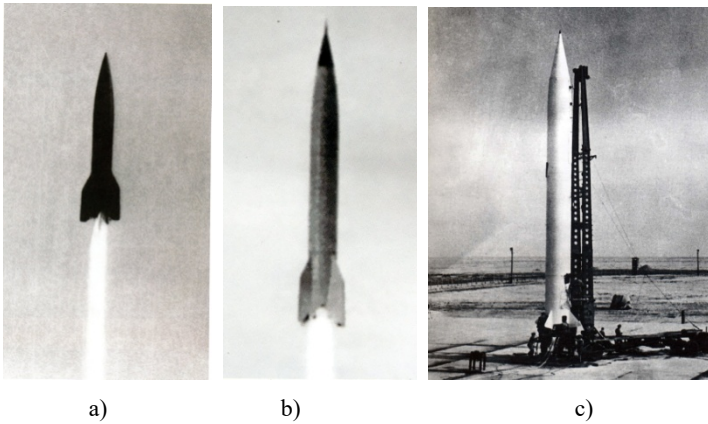
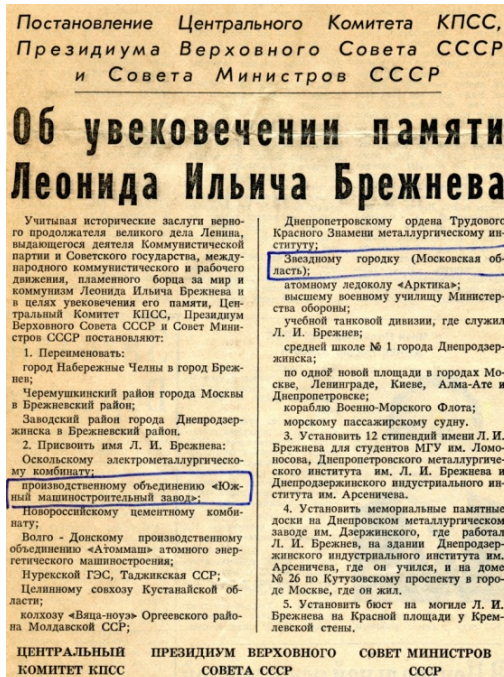


Figure 1.10. Order of May 10, 1951 (source: rights reserved)

In the 1980s, the Plant employed 53,600 people and produced up to 100 rockets/year, on average 18 satellites/year and up to 62,000 tractors/year. After the end of the USSR in 1991, it ceased to produce military missiles. As part of the conversion, it started the production of buses, trolleys, chassis for Antonov aircraft (An-140, An-148, An-158, etc.), wind turbines, etc. The workforce fell to 30,000, then to 20,000 in 1999, then to 16,500 in 2005 and then to 7,000 in 2014.



**Figure 1.11.** a) The first R-1 of Plant No. 586 launched in November 1952; b) the first R-2 of Plant No. 586 launched in May 1954; and c) the R-5M produced at Plant No. 586 in 1956 (source: rights reserved)

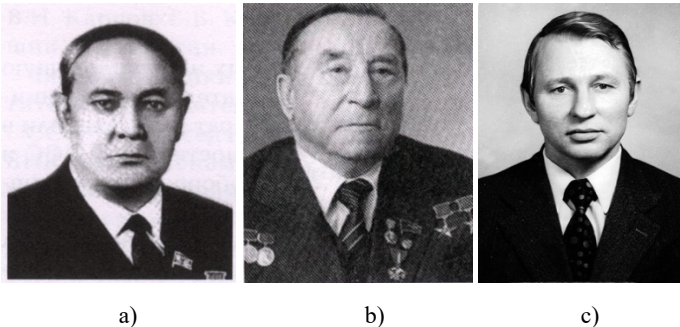


**Figure 1.12.** Pravda article on the baptism of the plant named after L.I. Brezhnev in 1982 (source: rights reserved)



In 2014, production of the Zenit rocket was suspended and the operator Sea Launch carried out its final launch. At the end of 2015, revenues amounted to approximately \$25 million compared to \$240 million in 2011. The plant was placed under short-term working and it seemed that bankruptcy was inevitable. In 2016, the Tsiklon-4 project with Brazil, which was to bring work to the plant, was halted, while Russian operator S7 purchased Sea Launch from RKK Energia. But S7, who wanted to purchase Zenit for Sea Launch, halted its discussions with YuzhMash. In 2017, Ukrainian entrepreneur Max Polyakov, who made his fortune from the Internet and founded the Californian company Noosphere Ventures, acquired the firm Firefly Aerospace, which develops the small Alpha liquid oxygen/kerosene launcher.

On July 21, 2019, the plant celebrated its 75th anniversary. That year, Firefly discussed a contract with YuzhMash for the production of 100 combustion chambers, 500 automation systems and 40 turbo pumps. But an unexpected event occurred: the boss of NKAU attempted to place YuzhMash under the control of Yuzhnoye to make the latter the beneficiary of the contract. But the plant opposed this and the boss of NKAU was replaced. Subsequent to this affair, the contract was not signed. In 2020, the plant reduced its workforce to 4,800 people and the government passed a law allocating €67.8 million to YuzhMash to repay debts owed to the state (taxes and loans) and employees (salaries). In the same year, it signed a memorandum with the South Korean company Caris for the production of 5,000 electric buses and 7,800 charging stations for approximately \$850 million. Over the past 28 years, the plant has produced 65 Zenit-2 and Zenit-3 rockets, 22 Dnepr rockets, 14 first stages for the American Antares launcher, 19 RD-843 engines for the fourth stage of the European Vega launcher, 14 satellites and aircraft landing gears (39 for An-14/158 and 38 for An-140).



**Figure 1.13.** a) L.V. Smirnov; b) A.M. Makarov; and c) L.D. Kuchma (source: rights reserved)

The Director of Plant No. 586 (YuzhMash in 1966, PO YuzhMash in 1978, named Brezhnev in November 1982) was successively G.M. Grigoriyev in 1950–1952, L.V. Smirnov in 1952–1961, A.M. Makarov in 1961–1986, L.D. Kuchma in 1986–1992, Yu. S. Alekseyev in 1992–2005, V.A. Shegol in 2006–2014 and S.N. Voit in 2014. In October 2019, the replacement of Voit by V.E. Kirichenko, Director of the Pavlograd mechanical plant, was announced, but did not materialize.

Leonid Smirnov (1916–2001) graduated from the Novochoerkassk Industrial Institute. He worked at arms companies, then studied at the Academy of Defense Industry in 1948–1949. He headed the Central Institute of Automatics and Hydraulics (TsNII-173) in 1949–1951 and became Head of the 7th Glavka (Rockets) from September 1951 to June 1952. He headed Plant No. 586 from June 1952 to March 1961. He was then Deputy Minister of the Defense Industry from March to June 1961 before succeeding K.N. Rudnev in 1961–1963. Ultimately, he succeeded D.F. Ustinov at the Head of the Military-Industrial Commission (VPK) in 1963–1985. He was awarded the Order of the Red Banner of Labor for the R-5M strategic missile in 1956, the Order of Lenin for the R-12 in 1959, the Lenin Prize for R-12 in 1960 and was twice awarded the Hero of Socialist Labor Medal (1961 and 1982).

Aleksandr Makarov (1906–1999) graduated from the Institute of Railway Engineers in Rostov. He worked in automobile companies, but was arrested in 1940 to be sentenced to eight years in prison and sent to a gulag where he built a railway. In April 1942, he was released and took over the management of a motorcycle plant in the Sverdlovsk region. In 1948, he arrived in Dnepropetrovsk to head the Automobile Accessories Plant. Two years later, he became Production Manager of Plant No. 586. He quickly rose in rank becoming Main Engineer in 1954–1961 and then Director in 1961–1986. He was awarded the Order of the Red Banner of Labor for the R-5M strategic missile in 1956, the Order of Lenin for the R-12 in 1959, the Lenin Prize for R-12 in 1960 and was twice awarded the Hero of Socialist Labor Medal (1961 and 1976) and the State Prize in 1981 (11K68/Tselina-D).

Leonid Kuchma (born 1938) graduated from the University of Dnepropetrovsk in 1960. He joined Yuzhnoye where he was an Engineer in 1960–1964, Lead Engineer in 1964–1966, Chief Designer of the Tsiklon-2 launcher (11K67 and 11K69) in 1966–1972, Technical Director for flight tests in Baikonur in 1972–1975, Party Secretary for OKB and the Plant in 1975–1982, First Deputy to the General Designer and Head of the Design Bureau in 1982–1986 and Director General of YuzhMash in 1986–1992. He then forged a political career: Deputy in 1990–1992, Prime Minister of Ukraine in 1992–1993 and finally President of Ukraine in 1994–2004. During this period, he denuclearized his country (dismantling 176 ICBMs carrying 1,240 nuclear warheads) and he supported the marketing of Yuzhnoye launchers: Tsiklon with Brazil, SS-18, which became Dnepr, Zenit-2 which became Sea Launch, then Land Launch. He was awarded the Order of the Red Banner of

Labor in 1976, the Lenin Prize in 1980 (11K69/US-P complex) and the State Prize of Ukraine in 2003.



**Figure 1.14.** *Layout of Plant No. 586, published in Jane's Defense Weekly on June 6, 1987, and an aerial view on July 21, 2019 (source: CIA and PivdenMash)*

Yuriy Alekseyev (born 1948) graduated from the University of Dnepropetrovsk in 1972. He joined YuzhMash where he began in the rocket-engine assembly shop. He became Deputy in 1985, then Main Engineer in 1988 and then Director General from October 1992 to July 2005. He headed the Ukrainian Space Agency from July 2005 to February 2009, and again from March 2010 until October 2014.



**Figure 1.15.** *Yu. S. Alekseyev (source: C. Lardier)*

Viktor Shegol (born 1951) graduated from the Dnepropetrovsk Institute of Technical Mechanics in 1971, served in the army in 1971–1973 and joined YuzhMash where he began in the satellite assembly shop. He graduated in engineering after taking evening classes at the Dnepropetrovsk Institute of Construction Engineers in 1980. He was Director General from October 2005 to 2013. He was awarded the Hero of Ukraine in 2004 and the State Prize in 2010.

Sergei Voit (born 1957) graduated from the Zaporizhia Technical School in 1976, the University of Dnepropetrovsk (PhysTech) in 1986 and the Alfred Nobel University in 2000. He worked at YuzhMash where he was First Deputy in 2005–2014, then Director General in March 2014. He was a Doctor of Economics and was awarded the State Prize of Ukraine in 2009 for the Sea Launch.

Key plant executives were the Main Engineer, Chief Technologist, Production Manager and Chief Metallurgist. The Main Engineers were successively S.N. Kurdin in 1951–1952, N.N. Kazakov in 1952–1954, A.M. Makarov in 1954–1961, N.D. Khokhlov in 1961–1965, L.L. Yagdzhiyev in 1965–1977, G.G. Komanov in 1977–1982, V.S. Sokolov in 1982–1987, V.A. Andreyev in 1987–1988, Yu. S. Alekseyev in 1988–1992, A.S. Korotkov in 1992–2010, V.I. Dyudov in 2010–2016 and V.V. Sokolov in 2016.

Sergei Kurdin (1912–2008) first worked at the No. 4 Gun Plant, which was evacuated to Krasnoyarsk in 1941–1943. He then became Chief Technologist at Kaliningrad Plant No. 8 in 1944. From May to November 1946, he was sent to Germany to study the V-2. He was the Chief Technologist for the R-1 and R-2 of Korolev. In 1951–1952, he was Main Engineer at Plant No. 586, then returned to the Korolev OKB in 1953–1957.



Nikolai Khokhlov (1918–1999) graduated from Bauman Technical University (MVTU) in 1941. He worked at Plant No. 8, which was evacuated to Perm in 1941–1943. It returned to Moscow and became Plant No. 88 in Kaliningrad. In 1951, he was appointed Head of Sector of the 7th Glavka of the Ministry of Armaments. In September 1952, he became Chief Technologist at Plant No. 586, then Main Engineer in 1961–1965. He obtained the Order of the Red Banner of Labor in 1956 (R-5M), the Order of Lenin in 1959 (R-12), the Hero of Socialist Labor Medal in 1961 (R-14) and the Lenin Prize in 1964 (R-16). In March 1965, he became Deputy Minister of General Machine Building (MOM) in charge of military and space rockets. He was then responsible for the companies of Korolev, Chelomei, Yangel, Makeyev, etc. In 1984, he fell victim to the plot that ousted MOM Minister Afanasyev and became an Engineer at NPO TechnoMash until 1996.

Lukas Yagdzhiyev (1910–1993) joined the Dnepropetrovsk automobile plant in 1947 where he became Shop Leader and then Head of Production in 1954–1959. In 1963, he graduated from the University of Dnepropetrovsk, then became Main Engineer of the plant in 1965–1977. He was awarded the Hero of Socialist Labor Medal in 1961 (R-14), the Lenin Prize in 1963 and the State Prize in 1977.

Gennady Komanov (1924–2003) was part of the first “space” graduation year group at the University of Dnepropetrovsk in 1954. He joined YuzhMash where he became Main Engineer in 1977–1982. He then became the Director of the Dnepropetrovsk subsidiary of the Institute of Machine-Building Technology in 1982–1987, First Director of the Dnepropetrovsk Youth Aerospace Education Center (NTsAOMU) in 1996–1997. He was awarded the Order of Lenin in 1961 (R-14), the Lenin Prize in 1961 and the Hero of Socialist Labor Medal in 1969 (25 years of YuzhMash).

Vladimir Sokolov (1930–2008) graduated from the Leningrad Mechanical Institute (LVMI or Voennmekh “Ustinov”) in 1954. He joined YuzhMash where he became Head of Satellite Production in 1962–1966, Deputy in 1966–1982, then Main Engineer in 1982–1987. He then became First Deputy at the Institute of Machine-Building Technology in 1987–1994. He was awarded the Lenin Prize in 1970 for the Meteor satellite and the Hero of Socialist Labor Medal in 1982.

Vladimir Andreyev (born 1942) graduated from the Zhdanov Metallurgical Institute in 1964. He joined YuzhMash where he became Chief Technologist in 1985–1987, then Main Engineer in 1987–1988. In 1988–1991, he was Head of the First Principal Directorate of MOM. He then headed the companies KompoMash in 1991–1993, Askond in 1993–1997, Kosmotras since 1997 (Director General, then Chairman in 2012). He was awarded the State Prize of Russia in 1986 and the State Prize of Ukraine in 2003.