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Chapter 28

Academician V. F. Utkin: General Designer of Space Launch Systems*

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Abstract

Academician Vladimir Fedorovich Utkin was a remarkable scientist and designer of rocket-space hardware. During 19 years, from 1971 to 1990, V. F. Utkin was General Designer of the Yuzhnoye Design Office (Yuzhnoye DO). In 1990–2000 V. F. Utkin was General Director of the Central Research Institute of Machine Building in Russia. Under the direct leadership of V. F. Utkin at Yuzhnoye DO several generations of strategic rocket systems were developed and built that have no analogues in the world, constituting the base of the strategic rocket forces of the Soviet Union and then—of Russia. The following were developed and built: one of the largest and most efficient liquid-propellant intercontinental ballistic missiles (ICBMs) SS-18 (Satana), solid-propellant silo- and rail-based ICBM Scalpel SS-24, environmentally pure Zenit launch vehicle, in addition to more than 400 spacecraft for scientific, national, economic, and military purposes delivered to orbit. During development a set of complex scientific and technical problems was solved, a number of original design and technological solutions were introduced: multiple and orbital reentry vehicles, pop-up start of heavy missiles from the container, long-term and uninterrupted stationing of

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liquid-propellant rockets in operational readiness, and missile resistance to the injurious effects of a nuclear burst. Under the leadership of V. F. Utkin the up-to-date Russian program of rocket-space technology development was developed.

Introduction

Academician Vladimir Fedorovich Utkin was a remarkable scientist and designer of the rocket-space hardware, Doctor of Engineering Sciences, Professor, twice Hero of Socialist Labor, Lenin, and State prize winner, and holder of six Orders of Lenin and many other government awards.

V. F. Utkin began work at Yuzhnoye DO in 1952 on graduating from Leningrad Military-Mechanical Institute (Department of Jet Ordnance). He was 29 years old, four of those years having been spent in the Great Patriotic war fronts, during which he was awarded battle decorations.

High-level engineering education, experience as a frontline soldier, and solid and persistent human characteristics in attaining the objective made it possible for him to achieve quickly a high professional level and become a charismatic leader of a large high-level body of specialists.

These years saw the formation of rocket-space engineering, and the development of domestic rocket production saw rapid growth. The Soviet Union and the United States competed to provide superiority of basic combat characteristics in their strategic missiles. During the first phase (the 1950s and beginning of the 1960s) the most important among those characteristics were as follows: firing range, operational readiness, and protection of launch positions against a potential opponent's air-rocket effects.

Yuzhnoye DO under the leadership of its founder and Chief Designer Academician M. K. Yangel solved the following important problems:

- essential increase of guaranteed periods of storage of rockets fueled at combat duty at the highest level of operational readiness
- increase flight range of ballistic missiles to intercontinental range
- transfer to a new launch type—silo basing of military missiles
- development of a new type of the combat hardware—multiple reentry warheads
- development of the principally new system to overcome the antimissile opponent defense the orbital warhead
- solve the problems of mobile basing of ballistic missiles.

V. F. Utkin actively joined in the solution of complex scientific and technical problems and made a valuable contribution to the development of the highly efficient strategic rocket systems. He passed through the great school of the scientific-technical and organizational management to develop and build the rocket-space systems under Michail Kuzmich Yangel, becoming his first deputy.

When M. K. Yangel died in 1971, V. F. Utkin took his post as Chief Designer and then General Designer of Yuzhnoye DO, continued worthy causes begun by M. K. Yangel, and kept his companions-in-work and the cooperation of developers.

Ideas and projects planned and uncompleted under M. K. Yangel were put into practice as real designs.

When Utkin became head of the Design Office, Yuzhnoye DO and Yuzhny Machine-Building Plant were already well known in military, industrial, and political circles of the Soviet Union. The Soviet army was equipped with several types of strategic rockets developed by Yuzhnoye DO. However the rapidly changing international situation required a renewal of armaments. To solve this problem, Yuzhnoye DO went two ways: updating rocket systems already in operation and developing new ones.

Utkin's strategy as head of the rocket-space design office was to find alternative scientific and technical solutions with minimum costs in response to the potential opponent's deployment of respective armament types. This made it possible to shorten the development time and avoid a faulty path of trial-and-error. It was just this way that assisted the development of original, nontraditional solutions and defined the appearance of rockets developed by Yuzhnoye DO.

Under V. F. Utkin's direction at Yuzhnoye DO several generations of strategic rocket systems were developed and built. These had no analogues in the world and formed the base of the strategic rocket forces in the Soviet Union, and then in Russia. Space rocket systems Cyclone and Zenit were developed and put into operation, in addition to a wide range of spacecraft.

Development of strategic rocket systems of the 1970s was conducted taking into account the following basic principles of the military-strategic concept in the Soviet Union of that day:

1. Increasing the survival probability of rocket complexes under any conditions of combat operations including under conditions of nuclear effect on them.
2. Increasing the kill probability of the most important objects of the potential opponent, protected by the long-term rocket defense system.
3. Increasing a storage period of rocket systems in the autonomous mode.
4. Reduction of the time to set rocket systems in the operational readiness.
5. Increasing the guaranteed operating life of rocket complexes.

For strategic rocket systems of the 1980s the prime object was to provide the invulnerability under confrontation with rockets having an extremely high firing accuracy.

Main results of V. F. Utkin's work as a General Designer of the Yuzhnoye DO are given below.

Family of Heavy Liquid-Propellant Intercontinental Operational Missiles

Updating of heavy liquid-propellant strategic silo-based rockets by means of improving efficiency of the rocket combat equipment, firing accuracy and operational readiness, launcher hardening, reliability, and operating characteristics was accomplished by developing and building a heavily hardened combat missile complex based on the 15A18M missile, better known throughout the world as the SS-18 (Satana). The SS-18 adopted by the Russian Army was one of the most efficient aids for containment of the potential opponent.

Basic technical solutions are as follows:

- silo high-hardened launcher
- rocket pop-up start from the transport-launch container installed in the silo launcher
- self-independent control system based on the onboard digital computer and set of increased accuracy command instruments
- multiple (10 units) separable warheads with an individual guidance of warheads to the target using the set of anti-missile defense penetration aids
- control system based on the resistive element base with a schematic-algorithmic hardening providing a serviceability at nuclear explosion effect
- direct guidance methods providing the possibility to calculate the fight task in flight
- command instruments operating continuously resulting in a provision of a high operational readiness
- full automatic control of all rocket systems
- operative remote retargeting of rockets during combat duty
- full ampoulization of propulsion systems of rocket stages
- multifunctional coating of full rocket length to protect against damage effects

Given its characteristics, the SS-18 has no analogues in the world and is practically invulnerable.

Family of Light Liquid-Propellant Intercontinental Missiles

Updating of light liquid-propellant intercontinental missiles was completed by putting the missile 15A16 (SS-17) into operation.

Basic technical solutions are as follows:

- silo automated high-hardened launcher
- rocket pop-up start from the transport-launch container installed in the silo launcher
- self-independent inertial control system based on the onboard digital computer with an automatic error measurement of command instruments and automatic correction input into the flight task
- self-independent onboard aiming system
- multiple separable warhead with four warheads
- ampoulization of propulsion systems of rocket stages
- foldable nose fairing.

Based on the missile 15A16 (SS-17), the special missile was developed for the highest command, which provided commanding, under extreme conditions, of response actions for all surviving forces.

Family of Solid-Propellant Intercontinental Missiles

While under M. K. Yangel, Yuzhnoye DO began its first study on solid-propellant missiles and reached definite successes. Multistage cartridge-pressure accumulators were developed and used during rocket pop-up start, in addition to unique engines to deploy multiple warheads with efficient control elements and other features.

Under the leadership of V. F. Utkin, Yuzhnoye DO began the full-scale development of solid-propellant intercontinental missiles of stationary and mobile basing. During development the cooperation of scientific and industrial organizations solved a number of great scientific and technical problems:

- development of new structural, thermal-protective, and erosion-resistive materials
- development of new solid propellants with unique power capabilities and operating characteristics
- development of plastic cases of solid-propellant cocoon-type engines, their manufacture by the winding method
- development and introduction of the thrust vector control system of the solid-propellant engine by hot gas injection from the combustion chamber into the nozzle

The development was completed by putting into operation the solid-propellant intercontinental missile SS-24 of a silo-basing (15Ж60) and rail-basing (15Ж61).

Basic technical solutions were as follows:

- rocket pop-up start from the transport-launch container installed in the silo or railway car
- self-independent control system, resistive against injurious effects of a nuclear burst
- multiple separable warhead with ten warheads
- terminal guidance methods
- flight control by the main compartment deviation
- pop-up stage separation
- structural detection by the special multifunctional coating

The silo-based SS-24 missile with its characteristics was on a par with the U.S. MX missile, and the combat railway system with its characteristics has no analogue in world rocket production.

Military missiles and the whole launch complex with combat crews and environment-control systems are arranged in a special railway train. If required, such trains can change location, which lessens the vulnerability of this rocket system.

For the SS-24 missile railway basing a number of complex problems was solved: launch point localization with a given accuracy, flight task calculation for the arbitrary launch point, motion safety, provision of the train "secret" location and others.

Family of Cyclone Light Launch Vehicles

The two-stage launch vehicle 11K69 (Cyclone-2) was developed based on the military missile 8K69 and put into operation within the antimissile defense system composition.

The three-stage light launch vehicle 11K68 (Cyclone-3) was developed based on ICBM 8K69 to launch spacecraft weighing up to 4,000 kg. An important property of the 11K68 was the possibility to start the third stage engine twice under weightless conditions, which essentially expands the possibility of launching spacecraft into various orbits.

The Cyclone-3 space rocket system developed on the basis of the Cyclone-2 launch vehicle with its ability to make prelaunch processing and launch of the vehicle automatic during the long term had no analogue in the world.

The Cyclone-3 was one from the most reliable launch vehicles in the world.

Zenit Medium-Class Launch Vehicle

The Zenit space rocket system was developed on the basis of the two-stage medium-class launch vehicle (payload weight up to 14.5 t). During this time specialists tried to develop launch vehicles based on military missiles, taking into account the reduction of development periods, low cost, and reliability.

V. F. Utkin had a subtle perception of requirements imposed at that time to the long-term promise of launch vehicles with respect to ecological demands, automatic control of launch operations, quick-firing, and other features. There was a need to solve a "bunch" of problems; as a result the new, special Zenit space system was developed and built without analogues in the world.

Basic technical solutions were as follows:

- pre-launch processing and vehicle launch were fully automated
- absence of repair-rebuilding operations at the launch complex after launch vehicle launch
- high efficiency of launches
- propellant components kerosene and oxygen are environmentally pure
- engines with unique power capabilities
- control system based on a high-accuracy set of command instruments and the quick-acting digital computer system
- launch vehicle terminal guidance
- lateral maneuver of the launch vehicle to reduce impact areas of separable parts and others

The Zenit launch vehicle first stage within the cluster of four units was used as the first stage in the Energia-Buran rocket-space system.

Spacecraft

Several tens of spacecraft types were developed and more than 400 spacecraft for defense, scientific, and national economic purposes were delivered to orbit.

A bright example of solving great national economic problems was shown using the Cosmos-1500 satellite to help the ship convoy that got into ice captivity in the East Siberian sea. Thanks to the radio-location survey (it happened during the polar night, under high cloudiness level), the optimum way of the convoy was determined, according to which it could exit from the ice field.

V. F. Utkin gave much attention to international cooperation in space. Jointly with French specialists, the Oreol spacecraft and others were developed; in cooperation with India, the Ariabata and Bhaskara satellites were developed and delivered to orbit.

As a leader, Vladimir Fedorovich Utkin gave attention to partners, colleagues in work, helped them in their hour of need, never restrained their initiative, completely trusted his companions, and was approachable and ordinary in contacts. As a General Designer, he went deeply into the minutest details, did not accept unsubstantiated assurances, required technical grounds and numbers and facts, and required a high professional skill, inventiveness, and persistence to achieve results required from subordinate specialists. His exactingness to himself and his associates was a continuous one. Much attention was given by V. F. Utkin during works with the cooperative enterprises, with ministries, and governing bodies of the country.

Working methods of V. F. Utkin and technical solutions achieved under his leadership even today assist the Yuzhnoye DO to remain the leader of rocket-space industry in Ukraine and work successfully in the world market of space services.