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On full alert for life

In 1973, a collection of poetry named "Fully Alert" was published in the city of Alma-Ata, including poems by an unknown author Grigory Vasilchenko. The neatly composed, melodious lines meant little to an ordinary reader, but they forced few tears from the eyes of iron men – professionals in their field, who by the will of fate and motherland were chosen to create the anti-missile shield of our state:

It's not the first time that I see this
But soul of mine is never calm,
When an anti-missiles's flying over
The wild shore of a-Lake Balkhash!

What anti-missile, what wild shore? These words were clear and dear only to the few chosen ones who were creating the world's first missile defence system (ABM defence). Among them, the verses of this author were spread by word of mouth and, being very popular, were turned into songs, accurately reflecting the essence of these people's life journey.

The author of these lines was Grigory Vasilievich Kisunko, Chief Designer of the experimental missile defence system (the A System), General Designer of the Moscow missile defence system (A-35 system), Hero of Socialist Labour, Corresponding Member of the USSR Academy of Sciences, Lenin Prize Laureate, Doctor of Engineering Sciences, Professor and Lieutenant General.

On July 20, 2018, the 100th anniversary of the birth of Grigory Vasilievich Kisunko was celebrated. His whole life can be compared to the state of full alert for an act of valour, for solving new tasks that he himself or the state set before him. He never doubted that it was possible to find a solution and engaged in making them real with great enthusiasm. Moreover, the more difficult the task was, the brighter Grigory's eyes burned, as he was anticipating the scale and complexity of its solution.

Grigory was born in a rural area, where his family faced financial struggles, which set the first task before him when he was a child: he had to choose his path for life. And the choice was made.

G. V. Kisunko left his village and moved to the city of Lugansk. There he entered the Faculty of Physics and Mathematics of the Donetsk Pedagogical Institute, from which he graduated in 1938 with honours in Physics. Then he entered a postgraduate course at the Department of Theoretical Physics of the Leningrad State Pedagogical Institute named after A. I. Herzen.

He graduated in June 1941, having successfully defended his thesis as a Candidate of Physical and Mathematical Sciences.

In Kisunko's PhD thesis "Theory of space charges in photoconductive crystals", the physical processes of interaction between light and electromagnetic plasma were studied in a detailed and comprehensive way. He laid out the engineering calculation methods that are still used in the design of radio-electronic equipment.

The outbreak of the Great Patriotic War posed a most difficult question to every citizen of the USSR – it was a question of life or death: working in the rear or fighting in the field?

The promising young scientist had no doubts about choosing his path. In July, he volunteered for the Leningrad People's Militia Army, but from there he was seconded to the Red Army and sent to study at the Military School of Air Observation, Warning and Communications Systems (VNOS).

After graduating from the school in February 1942, Lieutenant G. V. Kisunko was sent to the Special Moscow Air Defence Army. He served there until December 1944 as an assistant to the platoon commander and station chief for the technical part, as a platoon commander and station chief, and as an engineer of the aircraft radio detection station company.

While in the battle formations of the air borders defenders of the capital of our motherland, G. V. Kisunko proposed and implemented several original improvements in the design of the first Russian radars RUS-2 and MRU-105, which significantly improved their combat and performance characteristics.

Perhaps, the war years finally determined the direction of his further activities and formed G. V. Kisunko as a scientist. Tasks related to strengthening the defence capability of the USSR became his life's work.

As for the theoretical foundations of this responsible and difficult endeavour, G. V. Kisunko studied them thoroughly at the S. M. Budyonny Military Academy of the Signal Corps, where he worked his way up from the teacher to the head of the Department of Theoretical Foundations of Radar Location. He became one of the country's most experienced specialists in electrodynamics.

While working at the academy, combining teaching, research, and design activities, G. V. Kisunko completed and published a series of original works in the field of microwave technology, which were widely used as a theoretical basis for special engineering calculations and were included in many university and postgraduate courses.

Grigory's doctoral thesis was based on his fundamental work "Electrodynamics of hollow systems", published in 1946, and was dedicated to the problems of solving wave equations for boundary value problems of applied electrodynamics.

Being a true scientist by nature, Grigory could not be satisfied with only theoretical research. Practice has always served as the criteria of truth. He did receive an opportunity to apply his theoretical knowledge.

In October 1950, Grigory was seconded to the Ministry of Armaments of the USSR to work in the design and engineering department KB-1, where he fully participated in the scientific and technical revolution to rearm the air defence forces and to transfer from conventional artillery to surface-to-air missile complexes.

He helped create the first Russian surface-to-air missile system S-25 Berkut. Together with such venerable scientists as P. N. Kuksenko, A. A. Raspletin, S. A. Lavochkin, in the shortest possible time G.V. Kisunko built a fairly reliable system for protecting Moscow from the massive use of strategic bomber force. The world had seen nothing of the kind. This system was of extreme military, political, and strategic importance for the USSR.

In 1956, as part of the group who developed the S-25 system, Deputy Chief Designer G. V. Kisunko was awarded the title of the Hero of Socialist Labor.

It was not in Grigory's nature to rest on his laurels. Therefore, he took up a new job with great enthusiasm – this time a team of scientists was to create a mobile surface-to-air missile system S-75. G. V. Kisunko developed an antenna and waveguide transmission line for this system.

In 1957, the S-75 system was adopted. Thanks to its mobility, it was very often used in hot spots, in many wars and conflicts, and was victorious when fighting against the latest aircraft systems of the enemy.

Grigory was rightly proud of his brainchildren, the S-25 and S-75 systems. They became an insurmountable obstacle to the aggressive plans of our "sworn friends" (this was Grigory's favourite way of referring to unfriendly opponents), led by the United States.

This was also understood by the opponents of the USSR, who, in their aggressive plans, were becoming increasingly reliant on a new type of weapon – long-range ballistic missiles as the main means of delivering nuclear weapons to strategically important objects of the USSR. Nuclear missile weapons became the main trump card of the American diplomacy.

The air defence systems available in the USSR could not counteract them. A real danger of a nuclear missile strike on the country emerged, which is boldly declared in the historical materials that have become available to the general public in recent years.

New threats to the security of the state underscored the need to create missile defence for the most important strategic objects in the country. Unlike many venerable scientists who were skeptical about solving this problem, G. V. Kisunko actively supported the need and the possibility of solving the problem of combating the enemy's ballistic missiles.

He was not deterred by the words "this is just nonsense", "the marshals' fright", "this is as stupid as shooting a shell at a shell", "military dreamers", "in no case shall we give in to the proposals of the military", "this is nothing but an unsolvable riddle". These were indeed the statements that a number of well-known scientists voiced as a response to the Ministry of Defence, who in 1953 suggested that work should immediately begin on creating a missile defence system for the most important strategic objects.

Working on creating the anti-missile shield of our motherland became the pinnacle of G. V. Kisunko's scientific and design creativity.

He immediately realized that one of the most difficult problems of missile defence would be the one of accurately measuring the coordinates of the target and the anti-missile system, in order to solve the problem of hitting the target with a fragmentation warhead. The solution was found. To achieve the high accuracy level required, G. V. Kisunko proposed the so-called three-range method (or triangulation method). The method of parallel approach of the anti-missile with the target on opposite courses was chosen as a guidance method.

To implement the three-range method, G. V. Kisunko decided to use three fine guidance radars (RTN). Since Moscow was chosen as the object of defence, the most optimal option was to place the radars at the vertices of an isosceles triangle inscribed in the outer ring of the established Moscow S-25 Berkut air defence system with a radius of 85 km.

A similar "triangle" was to be built at the newly created missile defence test site near Lake Balkhash.

Thus, the basis of the future missile defence system was created. The A System included:

- the main computer and command centre of the system and central computing station;
- three anti-missile fine guidance radars, each consisting of a radar channel for detecting and tracking ballistic targets and a radar channel for capturing and tracking anti-missiles;
- radar station for sighting (aiming) of an anti-missile and an adjacent station for transmitting control commands to the anti-missile and detonating its warhead;

• the launching site where anti-missile launchers were placed;

• technical base for preparing anti-missiles.

All these facilities, located in the Betpak-Dala desert at distances of hundreds of kilometres from one another, were connected by a radio relay data transmission system.

The system provided a possibility to control the means of the experimental missile defence complex using an electronic computer in a single combat cycle from the main computer and command centre.

Given the transience of the process of intercepting ballistic missiles and the impossibility of human intervention, for the first time in Russia, almost the entire process of intercepting a target was fully automated using the M-40 digital computer (target and anti-missile lock-on for tracking was carried out manually by operators). This machine was one of the first developments of the Institute of Precision Mechanics and Computer Engineering of the USSR Academy of Sciences. The speed of the machine amounted to 40 thousand unicast operations per second, with RAM of 4096 four-bit words and representation of numbers with a fixed point. At that time, the M-40 was one of the most efficient computers in the world.

In the course of the A System testing, the team of academician Sergey Alekseyevich Lebedev upgraded the M-40. The new computer provided for executing floating-point computing operations and received the M-50 index.

Three fine-guidance radars were placed at the vertices of a regular triangle with sides of 150 km at three points of the Balkhash test site, respectively, 140, 240, and 180 km away from the modern city of Priozersk.

Thanks to the three-range method, the high accuracy of determining the coordinates of the target and anti-missiles when they were aimed at the target could be ensured. The ranges were measured with mean square deviations of no more than 5 m.

The V-1000 anti-missile stood out for its technical novelty – it was created by the team of the design and engineering department OKB-2 (now known as Machine-Building Design Bureau "Fakel") under the leadership of academician P. D. Grushin.

It was a two-stage missile with the world's most powerful solid-fuel booster and a controlled second stage with a liquid-propellant rocket engine. The average speed of the anti-missile was 1,000 m/s. The control system provided manoeuvring of the missile with overloads of 2–3 units and interception of the target at altitudes up to 25 km. The anti-missile was equipped with a unique combat fragmentation part designed by Konstantin Ivanovich Kozorezov. Tens of thousands of balls with explosive charges pressed inside served as damage agents. The centre of the weapon contained dense, high-strength balls of a smaller diameter.

On March 4, 1961, for the first time in the world's history, the A System successfully intercepted a target and hit the head of a ballistic missile R-12, flying at a speed of more than 3 km/s, with a high-explosive warhead of the anti-missile.

American scientists managed to do the same only more than 20 years later – on June 10, 1984.

In summer 1961, at the UN session, the First Secretary of the CPSU Central Committee, Chairman of the USSR Council of Ministers Nikita Khrushchev informed the global community that the USSR had created weapons that, in his apt expression, could hit "a fly in space". This is probably a better wording than "shooting at a shell with a shell".

The feat of the pioneers and the incredibly high pace of work are admirable: in 1953, no one in the country had clearly envisioned a missile defence system or had known whether it was possible to create it at all, and already in 1960, comprehensive tests of the experimental missile defence system started. Thus, almost from scratch, fundamental research was carried out, covering a wide range of the latest scientific fields

in the area of radar engineering, information transmission theory, rocket science, computer technology, automatic control theory, algorithmisation and programming, etc., which served as a theoretical basis for the creation of both technical means of the missile defence system and the defence system as a whole.

It should be noted here that, given the purposefulness, sometimes bordering on stubbornness, of the Chief Designer Grigory Vasilievich Kisunko, who was driven by scientific search, he could not bear to wait for the completion of the fundamental research. Therefore, experimental, design, and technological works of unique complexity were carried out in parallel, production facilities were created, a test site was built, and sometimes unsolvable organizational issues were solved.

All this was aimed at achieving a single goal: proving to the "well-wishers", and perhaps to himself too, of the possibility of intercepting and destroying the head of a ballistic missile.

The emergence in the USSR of a unique strategic defensive weapon, a missile defence system, instantly sobered many hot heads who were ready to immediately start a new world nuclear missile war and destroy the Soviet Union.

This achievement is the result of work of a huge team of civil and military scientists, researchers, testers, and other specialists. This is the result of colossal systematic efforts of state management bodies, industrial ministries and departments and the Ministry of defence to coordinate, at an unprecedented scale, the cooperation between the teams, developers, manufacturers, installation and military construction organizations, personnel of military units and military missions.

The great stimulus for this success was, of course, the Chief Designer of 'Annushka' (as developers lovingly called their brainchild), Grigory Vasilievich Kisunko.

In 1966, G. V. Kisunko was awarded the Lenin Prize for his work in the creation of the A System and related research.

The experimental missile defence system was the first and, as history has shown, the right step to create a combat missile defence system.

Positive results achieved in the development of the A System for the detection, tracking, and destruction of ballistic missiles offered a real prospect for creating a combat missile defence system. And, as was inherent in the character of G. V. Kisunko, he began to develop the project of a combat missile defence system without waiting for comprehensive tests of the experimental missile defence system to finish and immediately after receiving the first positive results in the detection and tracking of ballistic targets with the RE experimental radar.

At the end of 1959, G. V. Kisunko completed the preliminary design of the Moscow missile defence system: the A-35 system. In contrast to the experimental system, the combat missile defence system was supposed to intercept a group target at trans-atmospheric altitudes and long ranges, and the main means of destruction was an anti-missile with a special warhead.

On January 7, 1960, the Central Committee of the CPSU and the USSR Council of Ministers issued a resolution on the creation of the A-35 system. The team members were appointed, and the work schedules approved. Mass production of the system's assets began at the country's factories, and Pyotr Dmitrievich Grushin started developing the A-350 anti-missile system. The new anti-missile was supposed to have flight characteristics many times more advanced than the characteristics of the V-1000 anti-missile of the A System. The maximum range and height of interception of the anti-missile amounted to 350 km. The speed of the A-350 anti-missile exceeded that of the V-1000.

Uniqueness of the created system, novelty of the adopted technical solutions, high level of automation, limited possibility of full-scale launches of ballistic missiles, as well as a number of other factors set a major, independent scientific and technical problem before the creators.

It was necessary to develop a fundamentally new methodology for testing and putting the system into operation. To solve this problem, Special Computer Centre No. 4 was established (later renamed as the 45th Central Research Institute of the Ministry of Defence, and currently known as the Research and Testing Centre of the Central Research Institute of the Aerospace Defence Forces).

Colonel Ivan Makarovich Penchukov was appointed the first head of the Institute. The deputy head of the Institute for research work was Colonel Nikolay Panteleimonovich Buslenko. The Institute was incredibly lucky to have such people as its first heads. I. M. Penchukov was a brilliant organizer, father-commander, and N. P. Buslenko, a generator of scientific ideas, was the founder of the Soviet school of applied mathematics.

The first results of the research conducted at the Institute showed the complexity and scale of the tasks assigned to it. Nevertheless, the Institute developed an experimental and theoretical testing method in the shortest possible time.

As the subsequent practice of testing and commissioning of missile defence systems showed, this method was the only possible way to quantify the characteristics of complex armament systems in the entire range of their combat use, in conditions of extremely limited opportunities for conducting field experiments. The use of the combined experimental and theoretical method made it possible to conduct tests and adopt a number of important missile defence objects in a short time and with minimum financial costs.

The A-35 system was being created in an almost open struggle with the general designer of the system and a miniature "civil war" in the higher echelons of power. There was a "ram" trying to stop the A-35 System – or rather, the country's missile defence system called Taran, whose creators promised to make it more effective and, most importantly, cheaper. They did not manage to do it even on paper. It was only after the resignation of N. S. Khrushchev, who personally supported the developers of the Taran system, that work on all the objects of the A-35 system resumed.

On December 8, 1970, it was decided to start the official tests of the A-35 missile defence system, and on September 1, 1971, the head missile launch facility of the first stage of the A-35 system was put on experimental combat duty.

The country received a reliable shield, and military and political experts started to seriously assess the impact of missile defence on strategic stability. As a result, it was recognized that further development of the missile defence system would serve as a destabilizing factor and trigger the development of strategic offensive weapons. That is why, despite the diametric difference of ideological standings of the USSR and the United States, both countries made a mutual decision to hold negotiations on limiting missile defence systems and signing a corresponding treaty.

Moreover, the negotiations were conducted in such conditions when the Soviet industrial sector had already successfully implemented a whole range of anti-missile programs and obtained practical results. Undoubtedly, this was a trump card of the negotiators on our side.

There is another significant point to be made regarding the preparation of the ABM treaty. The initial proposal of the US did not imply negotiations on the limitation of offensive weapons, but in the end, the US side accepted the USSR's proposal to link the strategic offensive and defensive weapons in the treaty.

The result of the parties' willingness to reach a mutually acceptable compromise is well-known. Signed in 1972, the Treaty between the Union of Soviet Socialist Republics and the United States of America on the Limitation of Anti-Missile Defence Systems became the most important element of international law, ensuring the preservation of peace and strategic stability for 30 years to come.

Unfortunately, it was not possible to preserve the established mechanism of checks and balances between Russia and the United States. Relying on the myth of the growing missile threats

from North Korea and Iran, as well as taking advantage of the weakening of Russia's economic and military power, in 2001 the United States decided to unilaterally withdraw from the 1972 ABM Treaty.

From that moment on, the United States set a course for the creation of a global missile defence system.

It should be noted that the Russian Federation, throughout the entire period after the US withdrawal from the ABM Treaty, has consistently adhered to its main provisions. In addition, recently, at the initiative of the Russian side, the Russian Federation and the United States have repeatedly held talks on limiting the deployment of the US missile defence system. So far, to no avail.

Meanwhile, analysis of the current international situation shows that new challenges and threats to Russia's national security are emerging in the international sphere. There is a growing tendency to create a unipolar structure of the world with the economic and power dominance of the United States. The strategy of unilateral actions of the United States constantly destabilizes the situation at the global level, which provokes tension and generates more and more regional and local armed conflicts, including in the immediate vicinity of the Russian borders.

It is evident that the United States believed that nothing was holding them back any more, which was a wrong conclusion to make. Grigory Vasilievich Kisunko's work lives on, and the Russian missile defence system is developing. It expands the range of possible reactions of the country's military and political leadership to missile threats. The strategic missile defence system can reflect a missile strike of a given scale, which significantly reduces the threat of losing control of the country and the army at the initial stage of escalation of the armed conflict and allows you to increase the time to make an informed decision on the response actions of strategic nuclear forces.

I would like to finish with words of gratitude to our veterans, the creators and testers of the missile defence system, as well as those who used it in combat and operated it. You have done the impossible for our homeland and for making it safe, going beyond the limits of human capabilities. Thank you for this!

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