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Medical-biological and Psychophysiological Preparation of the First Manned Space Flight

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Abstract

The article is devoted to medical, biological and psychological research of the staff of the Research Testing Institute of Aviation Medicine in the interests of the development of aviation and the formation of manned cosmonautics. The contribution of the founder of space medicine V.I. Yazdovsky to ensuring the safety of stratospheric flights is noted. The directions of medical and biological research in the production of flights to the upper layers of the atmosphere are outlined. Archival documents and governmental decisions on the organization of work in the interests of space exploration are given. The results of the research of the Institute's employees after its transformation into the State Research Testing Institute of Aviation and Space Medicine are presented. The content of the preparation and training of astronaut students to perform the first manned space flight is outlined. The directions of medical-psychological and psychophysiological research, tests and training at the stages of preparation of astronaut students for the implementation of orbital space flight are shown. The decision to choose a candidate for the first orbital space flight is justified. Data on the tolerance of cosmonaut listeners to the expected effects of space flight factors are given. The participation of the Institute's employees in the preparation and implementation of the flight of Yu.A. Gagarin is shown. Final provisions and conclusions on the contribution of employees of the State Research Testing Institute of Aviation and Space Medicine to ensuring the safety of aviation and space flights are formulated.

Keywords: Medical and Biological Research; Space Flight; Yuri Gagarin; Selection of Cosmonauts; Tests and Training; Readiness for Flight; Flight Safety

The country's achievements in space exploration are largely related to the scientific feat of domestic scientists who stood at the origins of medical and biological support for the first manned space flights. These scientists worked at the Research Testing Institute of Aviation Medicine [5]. Its creation in 1947 met the interests of jet aircraft design. The lack of an independent research organization of aeromedical research in the structure of the Air Force reduced the efficiency of solving many issues of ensuring the pilot's performance and restrained the development of military aviation. This was especially acute in the first post-war years, when jet aviation was created and it was necessary to control the aircraft at high speeds, including during takeoff and landing, and to create means of rescue and ejection of the pilot in the event of depressurization of the cockpit.

Many studies of that period can rightly be considered pioneering developments. This applies to fundamental research on the justification of the pressure regime in hermetic cabins, the oxygen supply of the pilot to protect against explosive decompression during depressurization of the cabin, breathing under excessive pressure for flights at all altitudes, the development of anti-overload suits and chairs for ejection when leaving the aircraft in extreme situations.

However, the institute also laid the foundations of medical and biological training of manned space flights. In 1949, the

Scientific Research Testing Institute of Aviation Medicine was involved in the work of medical and biological support of flights to the stratosphere. At the Institute, these studies were headed by Vladimir Ivanovich Yazdovsky [1]. He often visited the design bureau of A.N. Tupolev in connection with his participation in the creation of hermetic cockpits of military aircraft and established himself as a businesslike, energetic and competent specialist. A.N. Tupolev noticed this and proposed his candidacy to S.P. Korolev. So V.I. Yazdovsky became responsible for conducting medical and biological research in the interests of space flights. Soon, headed by V.I. Yazdovsky, a group of employees was formed at the Institute to study the medical and biological problems of ensuring stratospheric flights.

In 1948, V.I. Yazdovsky became the head of the laboratory of medical and biological research for the development of life support systems for spacecraft. He was 36 years old when, together with S.P. Korolev, he was invited to the President of the USSR Academy of Sciences S.I. Vavilov to discuss the problems of the development of rocket technology. At the meeting, he was instructed to prepare a research program for medical and biological problems of high-altitude flights. The program of medical and biological research provided for the study of the possibility of flights at cosmic altitudes of living organisms in a hermetic cabin. The main provisions of the research program V.I. Yazdovsky outlined at the visiting session of the Academy of Medical Sciences, which its president, academician N.N. Anichkov, held at the Institute in 1949. The session was attended by leading physiologists of the country, including E.A. Hasratyan, K.M. Bykov, A.V. Lebedinsky, E.N. Pavlovsky, V.V. Parin, V.N. Chernigovsky and others.

In 1951, the institute began to carry out the first research work on the topic "Physiological and hygienic substantiation of the possibilities of flight in special conditions". The main objectives of the study were to develop requirements for sealed cabins, life support systems, rescue and control and recording equipment. Under the leadership of V.I. Yazdovsky worked researchers A.D. Seryapin and V.I. Popov and engineer B.G. Buylov. They developed methods for assessing the condition and behavior of animals in sealed cabins when flying to an altitude of up to 100 km and means of life support when separating the cabin for its descent by parachute [13]. The head of the missiles provided for a sealed cabin with a volume of 0.28 m^3 to accommodate dogs, a life support system and recording equipment.

For the first time in the world on July 22, 1951, a geophysical rocket was launched at an altitude of 100 km, in the hermetic cabin of which there were dogs Desik and Gypsy. When reaching an altitude of 100 km, the compartment with the animals separated and during the descent at an altitude of 7 km, the parachute opened, which ensured their safe landing [10]. In 1951, five more launches of single-stage geophysical rockets with animals took place. Not all of them were successful, however, the fact of animals' tolerance of conditions of short-term weightlessness was experimentally established. For medical and biological support of successful launches of high-altitude rockets R-1 and R-2A with animals to altitudes up to 110 km, V.I. Yazdovsky, A.D. Seryapin, V.I. Popov and the head of the Research Testing Institute of Aviation Medicine A.V. Pokrovsky were awarded the Stalin Prize in 1952.

In 1956, the Department of Research and Medical Support of Flights to the Upper Atmosphere headed by V.I. Yazdovsky was created at the Institute. Senior researchers O.G. Gazenko, A.M. Genin, I.S. Balakhovsky, E.M. Yuganov, A.D. Seryapin and B.G. Buylov studied the possibilities of active survival of animals in the hermetic compartments of missiles during long flights in the upper atmosphere. Installations were created for the long stay of animals for 15 days in hermetic conditions with automatic devices for nutrition and registration of physiological functions and hygienic parameters. In 1957-1958, 11 rocket launches were carried out to altitudes of up to 212 km and 3 launches to altitudes of 450-473 km. Responsible was the work on preparing the launch of the second artificial satellite with Laika [9]. Under the leadership of V.I. Yazdovsky, this was done by O.G. Gazenko, A.M. Genin, A.D. Seryapin, A.A. Gurdzhian, I.S. Balakhovsky and others. This flight, according to the figurative expression of V.I. Yazdovsky, became an important stage in the "biological sounding of future space flight routes and a test of the reliability of all spacecraft systems" [19].

In 1958, the publishing house "Knowledge" published a brochure with the title "Man in Space". On the cover as authors were I. Bach, O. Gorlov, V. Yakovlev, E. Yugov. These were the pseudonyms of scientists of the Research Testing Institute of Aviation Medicine Igor Sergeevich Balakhovsky, Oleg Georgievich Gazenko, Vladimir Ivanovich Yazdovsky, Evgeny Mikhailovich Yuganov. Other employees of the Institute, in particular, A.M. Genin, A.R. Kotovskaya, I.I. Kasyan, A.V. Pokrovsky and A.D. Seryapin, published, respectively, under the pseudonyms A.M. Galkin, A.R. Kotova, I.I. Kosov, A.V. Petrov and A.D. Serov.

Resolution Of the Central Committee of the CPSU and the Council of Ministers of the USSR of January 5, 1959 No. 22-10 "On Strengthening Research Work in the Field of Medical and Biological Support of Space Flights" of the Academy of Sciences of the USSR, the Academy of Medical Sciences of the USSR and the Ministry of Defense of the USSR was instructed to consider the most important task the solution in the coming years of all issues related to the medical and biological support of human space flights. By the same decree, the Research Test Institute of Aviation Medicine of the Ministry of Defense of the USSR was transformed into the State Research Test Institute of Aviation and Space Medicine of the first category.

In pursuance of the decree of the Directive of the General Staff of the Air Force of March 14, 1959, three scientific areas are being created at the State Research Testing Institute of Aviation and Space Medicine. Employees of one direction dealt with the problems of aviation and space hygiene of cabins and spacesuits, uniforms and special equipment, food and aerospace toxicology. Research problems of another direction were the issues of aviation and space physiology, accelerations and weightlessness, physiology of hearing, speech and vestibular analyzer, as well as physiological optics. And another direction was created to conduct special research with the departments of medical support for the safety of flights on rockets, medical research on the impact of space flight factors, medical selection and training of rocket ship crews.

The head of this special scientific direction is appointed V.I. Yazdovsky. A.M. Genin became his deputy and at the same time the head of the department of life support systems, O.G. Gazenko was appointed head of the department of space physiology, and N.N. Gurovsky was entrusted with the head of the department of selection and training of cosmonauts. Other departments of the Institute were also involved in solving the problems of space medicine [6]. To solve the problems of medical and biological support of space flights, the institute's employees actively interacted with other organizations, including for the development of ejection and landing facilities, regeneration and air conditioning systems, conducting familiarization and training flights on aircraft with the creation of short-term weightlessness.

At the Institute, the departments of medical study of flight work, biochemical and radiobiological research, psychology, medical study of flight accidents and the development of scientific and experimental equipment become independent. The head of the State Research Testing Institute of Aviation and Space Medicine is A.G. Kuznetsov. The tasks of large-scale medical and biological research are the development and testing of life support systems and individual means of ensuring the safety of space flight in ground experiments, the preparation of astronauts for flight, the study of the influence of flight factors on their body and the control of life support and rescue systems.

In accordance with the resolution of the Central Committee of the CPSU and the Council of Ministers of the USSR of May 22, 1959 "On the preparation of man for space flights", the staff of the Institute was engaged in the selection and training of candidates for the first orbital space flights. Employees of the Central Military Research Aviation Hospital took an active part in their medical selection and training. According to the directive of the General Staff of the Air Force of January 11, 1960, a unit of cosmonaut students was created at the Institute, which later became the Cosmonaut Training Center.

Resolution No. 1388-618 of the Central Committee of the CPSU and the Council of Ministers of the USSR of 10 December 1959 "On the Development of Research on Outer Space", attaching great importance to the exploration of outer space and ensuring the country's leading role in this area, defines the directions of work for the further study of outer space. By the same decision, the State Research Testing Institute of Aviation and Space Medicine is determined by the leading organization for space exploration in terms of conducting medical and biological research and solving problems that ensure human life on space rockets.

Under the leadership of V.I. Yazdovsky, the Institute, with the participation of the Research Aviation Hospital and other organizations, carries out research work on the topic "Selection of a person for space flight" and on the topic "Preparation of a person for the first space flight". The "Instruction on selection for members of medical commissions" is prepared and approved by the Deputy Commander-in-Chief of the Air Force and the Main Medica.

As a result of the selection, in-depth medical examination of candidates and additional studies and tests in March 1960, I.N. Anikeev, P.I. Belyaev, V.V. Bondarenko, V.F. Bykovsky, V.S. Varlamov, B.V. Volynov, Yu.A. Gagarin, V.V. Gorbatko, D.A. Zaikin, A.Y. Kartashov, V.M. Komarov, A.A. Leonov, G.G. Ne-lyubov, A.G. Nikolaev,

P.R. Popovich were selected as cosmonaut students to prepare for space flight. M.Z. Rafikov, G.S. Titov, V.I. Filatiev, E.V. Khrunov and G.S. Shonin. Their training was carried out on the basis of the Cosmonaut Training Program, approved by the Interdepartmental Scientific and Technical Council for Space Research under the Presidium of the USSR Academy of Sciences and the Commander-in-Chief of the Air Force.

The publication of the materials of the project of the Russian State Archive of Scientific and Technical Documentation, dedicated to the 60th anniversary of the flight of Yu.A. Gagarin, allows us to fully and consistently present his biography and medical and psychological aspects of the selection and preparation of a special group of cosmonaut students to perform a space flight [17]. They follow from the analysis and generalization of the published "Brief Report on the Training of Cosmonaut Students of the Special Group of the Air Force Cosmonaut Training Center" by E.A. Karpov, the Act on the Results of The Examinations Conducted with Cosmonaut Students of the Air Force Cosmonaut Training Center, the List of Questions Submitted to the State Examination of the Students of the Air Force Cosmonaut Training Center, the project "Brief Description of the Pilot's Work in Manual Control of the Descent of the Vostok-3A Object from Orbit", reports of Yu.A. Gagarin about flights «to weightlessness» and other archival materials.

On March 14, 1960, at 9 o'clock in the morning, the training of cosmonaut students began and those who had arrived by that time met with V.I. Yazdovsky at the first lesson. It was he who told what they should prepare for, and what awaits them in space. Initially, the training program focused on the medical and biological problems of space flight. In this regard, astronaut students got acquainted with the basics of space and aviation medicine and life support in space flight [7]. In his memoirs, Yu.A. Gagarin expressed gratitude to the staff of the State Research Testing Institute of Aviation and Space Medicine for the situation and conditions in which the first cosmonaut students were trained for space flights: "We were in ideal conditions.

We had everything, nothing distracted from our favorite, interesting activities. We treated our doctors with respect. It was they who determined the conditions that ensure the life and health of a person in the cockpit of a spacecraft, took an active part in its creation, in the development of a reliable spacesuit and scientific medical recording equipment. " The cosmonaut training program included theoretical classes in aviation and space medicine and special tests and training, during which the issue of selecting an astronaut for the first space flight was decided. At the first stage, an increase in the general physical fitness of astronauts and the development of special physical qualities were ensured.

At the second stage, while maintaining the achieved level of general physical fitness, the body's readiness for better tolerance of overloads, weightlessness and vestibular effects was ensured. As a result, the increase in efficiency, endurance, strength, speed and coordination of movements necessary for the implementation of space flight was achieved. Parachute training was carried out in order to form the cosmonauts' skills in performing a parachute jump, taking into account the design features of the Vostok spacecraft, and was a way to assess and train emotional and volitional qualities. Jumps were performed on land and on water, day and night, from high and low altitudes, with a delay and without delay in the opening of parachutes. To train and acquire skills in performing operations necessary in flight and studying the individual characteristics of astronauts, a stand-simulator created for training was used.

At the same time, actions in emergency situations were practiced. The greatest difficulty was the conduct of radiotelegraph communication to transmit information about the operation of the ship's systems and the actions performed. Special attention was paid to training on the treadmill and swings of Khilov, in the Barani chair, in baro-, thermo- and deaf chambers, on a vibration stand and a centrifuge. Astronauts developed the skills to control their condition during overheating and resistance to high air temperature. Tests in the thermal chamber were carried out taking into account the possible increase in air temperature in emergency situations on board the ship. In connection with the impact on astronauts during takeoff and landing of accelerations, an important element of their training was training on a centrifuge. To prepare the body for the effects of flight factors, much attention was paid to general physical training. A lot of time was devoted to flights on laboratory aircraft specially equipped to create short-term weightlessness.

To create short-term weightlessness at an altitude of 6 km, acceleration was carried out on the afterburner, then cabring, entering a parabolic trajectory with an apogee at an altitude of 9

km, then diving with access to horizontal flight at an altitude of 6 km. This made it possible to assess the reactions of the body, to study the effect of weightlessness on the cardiovascular and respiratory systems, vision and speech during radio exchange, coordination of movements and food intake. As a result, it was concluded that the short-term effect of weightlessness on the human body does not cause adverse sensory reactions, does not worsen the general well-being of astronauts, does not violate the coordination of movements, does not entail pathological reactions from the cardiovascular and respiratory systems.

A significant place in the preparation was given to training in flight equipment in a sealed model of the Vostok spacecraft: the elements of the flight task were worked out, the initial data on the state of the neuro-mental sphere, performance and basic physiological functions of the cosmonauts were recorded. The individual fit of flight suits, methods of fastening electrodes and sensors for recording physiological functions were checked, and the diet was specified.

In accordance with the Regulations on the Cosmonaut Training Center, approved on May 7, 1960 by the Commander-in-Chief of the Air Force, the center was subordinate to his deputy for combat training and was transferred to the operational management of the head of the Aviation and Space Medicine Service. The construction of infrastructure facilities for the training of cosmonauts was completed in the summer of 1960, and then the cosmonaut students were able to move to the Green (now Star City).

In the process of preparation for accelerated preparation for the first space flight, a special group consisting of Yu.A. Gagarin, V.S. Varlamov, A.Y. Kartashov, A.G. Nikolaev, P.R. Popovich and G.S. Titov was allocated from the cosmonaut students. After being suspended on 16 July 1960 from medical trials and training, A.Y. Kartashov was included in the group G.G. Nelyubov, and after V.S. Varlamov, who received a spinal injury on July 24, 1960, V.F. Bykovsky was included in the special group. Students-cosmonauts of the special group underwent special tests and training more intensively according to a special plan. The preparation of the selected "six" cosmonaut students for the manned flight was carried out intensively. Yu.A. Gagarin wrote: "Our classes continued at an accelerated pace. We trained more and more often in the layout of the cockpit of the spacecraft, settled it as a new house, got used to each button and toggle switch, worked out all the movements necessary in flight, brought them to automatism. The hands knew what to do anyway. The ability to handle the systems of manual control of the spacecraft, orientation, landing, as well as thermal regulation, air conditioning, pressure control was worked out" [3].

All this time, V.I. Yazdovsky and his employees continued to be engaged in ensuring the medical and biological safety of the first orbital flight [12]. A preliminary check of the reliability of the flight medical safety system was carried out with the participation of animals. On August 18, 1960, the dogs Belka and Strelka went into space. For the first time, a spacecraft with animals that have made an extraterrestrial journey has returned to Earth. Their orbital flight lasting more than a day showed that staying in conditions of weightlessness and braking overload during the descent of the ship to Earth, as well as cosmic radiation, did not pose a threat to the life of animals. The ship's technical systems, including life support, descent and landing, functioned reliably.

The safe return of animals to Earth became a harbinger of human flight into space and the basis for subsequent tests of a maskless spacesuit, personal protective equipment, life support systems and landing with the help of an ejection seat and in the ship itself. The next flight on the satellite spaceship on December 1, 1960 went the dogs Pchelka and Mushka, followed by the flight of the dog Chernushka on March 9, 1961 and the dogs Zvezdochka on March 25, 1961. The data obtained confirmed the ability of a person to withstand the effects of space flight factors without adverse consequences. These studies served as the basis for making a final decision on the possibility of human flight on the Vostok spacecraft [18].

By the order of the head of the Cosmonaut Training Center of January 4, 1961, cosmonauts Captains V.F. Bykovsky, A.G. Nikolaev, P.R. Popovich and Senior Lieutenants Yu.A. Gagarin, G.G. Nelyubov and G.S. Titov, who completed the training, testing and training program and studied special theoretical disciplines, were admitted to the exam "for readiness to perform the duties of a cosmonaut".

The main disciplines of theoretical training of cosmonaut students were Marxist-Leninist training, rocket and space technology, design and operation of the Vostok-3A facility, aviation and space medicine, astronomy, geophysics, astronavigation and filming. Practical training included regular classes in various types of general physical training, training when working on mock-ups

of the Vostok-3A object, flying on the MiG-15UTI aircraft with the creation of short-term weightlessness, parachute training, as well as training in telegraph communications.

In the process of training, cosmonaut students underwent in-depth clinical and physiological examinations and were subjected to special tests and trainings, including in a hyperbaric chamber, in a thermal chamber and on a vibrating stand, as well as in a surdo- or hyperbaric chamber in isolation from the outside world.

Tests in the hyperbaric chamber were of an introductory and training nature. The individual resistance of the body of listeners-cosmonauts to hypoxia and a decrease in the partial pressure of oxygen in the air was evaluated. At the same time, they were trained to assess their condition and timely identify signs of hypoxia that precede a malfunction. In addition, they formed a readiness to maintain operability with the help of protective equipment in the event of depressurization of the cabin. To do this, in the hyperbaric chamber, they "rose" 4 times to a height of 5000-6000 m without means of protection against hypoxia and to a height of 14,000-15,000 m in protective equipment with breathing oxygen under excessive pressure. According to the observation and registration of pulse, blood pressure, breathing frequency and other indicators, all students-cosmonauts of the special group demonstrated good tolerance of hypoxia and resistance to a decrease in the partial pressure of oxygen in the air.

Orientation and training tests were also carried out on a centrifuge. When the spacecraft enters orbit and the descent vehicle enters the dense layers of the atmosphere, overloads occur. In this regard, it seemed necessary to assess the tolerance of astronaut listeners of overloads and increase the body's resistance to their action. Training on a centrifuge with an impact of up to 40 seconds of overloads of 3-8 units of the head-pelvis direction was carried out twice, and with the impact of up to 13 minutes of overloads of 7-12 units of the chest-back direction seven times. In addition, the astronaut students of the special group successfully endured the impact of the 12-unit overload on the centrifuge in a space suit.

To assess the individual tolerance of vibrations by astronaut listeners, tests were conducted on a vibration stand. At the same time, vertical vibrations with a frequency of 50 Hz and an amplitude of oscillations of 0.5 mm acted within an hour. According to the registration of pulse, blood pressure, respiratory rate and electrocardiogram, all listeners demonstrated a high level of tolerance to vibration effects.

The assessment of the neuro-mental stability of the astronaut listeners was carried out based on the results of their solitary stay in a surdo- or hyperbaric chamber in conditions of sensory isolation for 10-15 days. At the same time, their psychological and functional state was assessed, including changes in the indicators of the cardiovascular and respiratory systems, metabolism and other criteria. Analysis of the data obtained showed that all students of the special group tolerated the test well in conditions of prolonged loneliness and demonstrated a high level of psychological stability and functional capabilities.

Taking into account the possible increase in the air temperature in the cockpit of the spacecraft in emergency situations, tests were carried out in a thermal chamber of evaluation and training orientation. With all students-cosmonauts, 9 trainings were conducted at an air temperature of + 70 ° C and air humidity up to 10%. As a result of training, the tolerability time of stay in the thermal chamber was consistently increased from 30 minutes to 2 hours. All students showed a high level of resistance to heat load.

The familiarization and training nature was carried out by the flights of listeners-cosmonauts of the special group on the MiG-15UTI aircraft, converted to create weightlessness. The flights were conducted from May 20 to July 15, 1960 by the State Red Banner Research Institute of the Air Force at the Chkalovskaya airfield. Each listener participated in 4-5 flights with three Kepler parabolas performed in each. The time spent in zero gravity in flight on a parabola was 35-40 seconds. In addition to familiarizing students with the effect of weightlessness in flights, its effect on the functions of the cardiovascular and respiratory systems, coordination of movements and visual acuity was evaluated. The possibilities of drinking water and taking solid and paste-like foods were also studied.

The quality of radio communication by changing speech in conditions of weightlessness and overloads was evaluated. The results of the study showed good tolerance of the state of weightlessness of the specified duration by all astronaut listeners. At the same time, they were convinced of the possibility of normal

intake of food and water, the implementation of coordinated actions for keeping records, perceiving the readings of devices, as well as conducting radio conversations and orientation in space.

Parachute training was an integral part of the training of astronaut students for landing by parachute after the completion of the space flight. To form and consolidate the skills of using a parachute in the summer of 1960, each cosmonaut student made at least 35-37 jumps. Parachute jumps were made from a height of 800-4000 meters, including with a delay in the opening of the parachute up to 80 seconds. Landing was made on solid ground with wind speeds of up to 8 m / s. One jump was performed with splashdown. As a result of parachute training, students not only developed stable skills in performing jumps with the opening of the parachute dome with the required delay in time, but also controlling the body during free fall. All students of the special group of preparation for space flight were awarded the title of "Instructor of parachute service".

Physical training of astronaut students was carried out in two stages. In the first phase, the focus was on improving the level of general physical fitness. Classes were conducted in a group way, physical activity and the means used were common to the group. As a result of the conducted classes, all cosmonaut students increased their overall physical fitness, strength qualities and coordination of movements improved. At the second stage, classes with students were conducted by an individual-group method for the purposeful development of individual qualities and skills, including physical exertion of increased intensity and duration. Physical training classes included exercises that required emotional-volitional tension.

Deputy Chief Designer of OKB-1 of the State Committee of the Council of Ministers of the USSR on Defense Equipment Bushuev December 22, 1960 for ref. No. 0/5679 sent to the head of the Flight Research Institute of the State Committee for Aviation Technology N.S. Stroev and to the State Research Testing Institute of Aviation and Space Technology of the Ministry of Defense of the USSR for E.A. Karpov the draft "Brief description of the pilot's work in manual control of the descent of the Vostok-3A object from orbit. At the same time, the final text of the instruction was proposed to be issued after training on the layout.

The Instruction indicated that manual control of the descent is supposed to be used if it is impossible to lower the object with commands from the Earth in case of failures, in particular, the automatic orientation system and the granit-5V software-time device or for the implementation of an urgent descent of the object due to a malfunction of the systems that ensure the life of the pilot, depressurization of the cockpit and the impossibility of using orientation in the Sun.

An important part of the training of students-cosmonauts of the special group were classes on the study of equipment and systems of the Vostok-3A facility and training on practicing actions in emergency situations. These trainings were carried out directly on the layout No. 1 of Vostok-3A in OKB-1 and on its layout No. 2 at the Flight Research Institute [4]. In addition, the students studied and practically mastered the astronomical method of determining the location in an unfamiliar area using a sextant and developed the skills of receiving and transmitting the telegraph alphabet.

In the process of all these special tests and trainings, medical control was constantly carried out. It was carried out through systematic medical observation and in-depth clinical and physiological studies. Analysis of the data obtained showed that all students-cosmonauts of the special group for the state of health, physiological reactions and compensatory capabilities of the body, as well as for the level of general physical training and training fully meet the requirements for astronauts.

By the order of the head of the Air Force Cosmonaut Training Center of January 4, 1961 No. 001, the students-cosmonauts of the special group Captain V.F. Bykovsky, Captain A.G. Nikolaev, Captain P.R. Popovich, Senior Lieutenant Yu.A. Gagarin, Senior Lieutenant G.G. Ne-lyubov and Senior Lieutenant G.S. Titov, who successfully completed the program of special medical research, tests and training and showed good knowledge of special theoretical disciplines, were admitted to the exam for readiness to perform the duties of an astronaut.

On January 14, 1961, another medical examination of the cosmonaut students of the special training group was carried out. By the decision of the medical commission, all six were allowed to perform a space flight.

Examinations for six students-cosmonauts of the special group of the Air Force Cosmonaut Training Center on January 17-18, 1961 were taken by a commission appointed by the order of

the Commander-in-Chief of the Air Force of January 6, 1961 No. 003, consisting of Chairman N.P. Kamanin, Deputy Chairman A.N. Babiy-chuk and members of the commission N.M. Sisakyan, K.P. Feoktistov, S.M. Alekseev, M.L. Gallai, Yu.M. Volynkin, V.Y. Klokov, V.I. Yazdovsky and E.A. Karpov. On January 17, 1961, exams were held on the design, operation and development of practical skills in controlling the Vostok-3A object on the current layout at the Flight Research Institute in Zhukovsky [11]. On January 18, 1961, exams for special theoretical courses were taken at the Air Force Cosmonaut Training Center.

The exams were taken by students-cosmonauts captains V.F. Bykovsky, A.G. Nikolaev and P.R. Popovich and senior lieutenants Yu.A. Gagarin, G.G. Nelyubov and G.S. Titov. A list of questions related to the Vostok-3A object, rocket and space technology, the basics of aviation and space technology was submitted for the exam. With regard to the Vostok-3A object, the questions concerned its purpose and technical characteristics, the flight program, the operation of automatic and manual orientation systems and thermal control and regeneration systems, the dashboard and control panel, as well as the device of control systems, emergency rescue and radiotelegraph communications.

In the section of rocket and space technology, the questions concerned the rocket engine, the basic laws of solid state mechanics and celestial mechanics, the design of spacecraft launch vehicles, the launch of the Earth's satellite into orbit and its descent from orbit, research with the help of Earth satellites. In the section of space and aviation medicine, the questions concerned the basic concepts and vital systems of the body, high-altitude physiology, precursors and symptoms of oxygen starvation, as well as the influence of overloads and other factors of space flight on the basic physiological functions of the body.

The "Act on the results of examinations conducted with students-cosmonauts of the Air Force Cosmonaut Training Center" states that the cosmonaut students who underwent the exam showed excellent knowledge of the device and operating rules of the Vostok-3A facility, as well as skills in managing the object on its layout in relation to all stages of the flight, including special cases. It is emphasized that the students showed solid knowledge of special theoretical courses. The Commission also noted that during the training period, cosmonaut students took the initiative in studying technology, took part in the development and improvement of various special equipment and equipment, increased personal discipline, organization and actively participated in the public life of the unit.

The Commission considered personal files, study cards, service and clinical-physiological characteristics, medical and flight books, as well as data on the general physical condition and the results of tests, research and training, and concluded that the cosmonaut students had successfully completed the training program and, for the state of their health, as well as the level of physical fitness achieved, met the requirements for cosmonauts.

On the basis of the examinations, the study of materials and documents, the examination commission made a conclusion on the readiness of the examined students to perform the duties of cosmonauts, assessing the knowledge of all students-cosmonauts as excellent. In addition, the members of the commission considered it necessary to "tentatively" recommend the following order of candidates for the first space flight: Senior Lieutenant Yu.A. Gagarin, Senior Lieutenant G.S. Titov, Senior Lieutenant G.G. Nelyubov, Captain A.G. Nikolaev, Captain V.F. Bykovsky and Captain P.R. Popovich.

At the same time, the commission concluded that the educational process at the Air Force Cosmonaut Training Center is organized and conducted correctly. Students-cosmonauts of the special group received solid theoretical knowledge and practical skills that they will be able to use both during the preparation for the space flight and during the flight itself. By the whole complex of medical tests, special trainings and service-party education, cosmonaut students Senior Lieutenant Yu.A. Gagarin, Senior Lieutenant G.S. Titov, Senior Lieutenant G.G. Nelyubov, Captain A.G. Nikolaev, Captain V.F. Bykovsky and Captain P.R. Popovich are prepared to perform the duties of a cosmonaut.

By the time the exam was passed, the industry had not yet established the production of a portable emergency stock. Training on the section of life support of astronauts after landing by parachute was not completed. With this in mind, the commission proposed to continuously continue the development of astronauts of new means and equipment coming from industry, as well as to maintain a high level of physical fitness.

On the basis of the Act, the Commander-in-Chief of the Air Force, by order of January 25, 1961, appointed cosmonaut students Yu.A. Gagarin, G.S. Titov, G.G. Nelyubov, A.G. Nikolaev, V.F. Bykovsky and P.R. Popovich, who successfully completed the cosmonaut training program and showed excellent knowledge in the exams, to the posts of cosmonauts of the Air Force Cosmonaut Training Center. On February 20, 1961, the cosmonauts began classes at Plant No. 918 to study the spacesuit, chair and wearable emergency stock. On March 17-24, 1961, they visited the 5th Research Test Site of the Ministry of Defense of the USSR, where they conducted training on the Vostok-3KA spacecraft in the assembly and test building.

Research Testing Institute of Aviation and Space Medicine switched to a new staffing table. Yu.M. Volynkin is appointed head of the institute, and the number of employees doubles. The Departments of Aviation and Space Medicine are being created. V.I. Yazdovsky becomes the head of the Space Medicine Department and Deputy Head of the State Research Testing Institute of Aviation and Space Medicine.

In this management, the department of closed systems of the cycle of substances in the cockpits of spacecraft was headed by E.Y. Shepelev, the department of physical and chemical methods of air regeneration was headed by A.D. Seryapin, the department of research on the conditions of habitability of spacecraft was headed by A.G. Kuznetsov, the department of individual means of ensuring the safety of space flights was entrusted to S.A. Gozulov, the department of space physiology was headed by O.G. Gazenko, the department of radiobiological research was headed by P.P. Saksonov, the department of space flight safety space simulators - A.P. Kuzminov and the department of decoding and scientific analysis of radiotelemetric information was headed by G.V. Altukhov [2].

On March 29, 1961, the State Commission chaired by K.N. Rudnev heard a report by S.P. Korolev on the results of the launches of seven Vostok spacecraft and on readiness for a manned flight. On the same day, a meeting was held under the chairmanship of D.F. Ustinov, at which readiness for a manned flight was confirmed. On April 3, 1961, a meeting of the Presidium of the Central Committee of the CPSU was held, at which, after the report of D.F. Ustinov, it was decided to carry out the world's first human flight into space. On April 5, 1961, the cosmonauts flew to the cosmodrome in two planes. On one Y.A. Gagarin, G.G. Nelyubov and P.R. Popovich, and on the second G.S. Titov, A.G. Nikolaev and V.F. Bykovsky.

On April 5, 1961, the cosmonauts flew to the cosmodrome in two planes. On one plane flew Yu.A. Gagarin, G.G. Nelyubov and P.R. Popovich, on the other - G.S. Titov, A.G. Nikolaev and V.F. Bykovsky. On April 8, 1961, the deputy head of the State Research Testing Institute of Aviation and Space Medicine, V.I. Yazdovsky, approved the Program of Medical Observation and Health Control of Cosmonauts in the Pre-Launch Period for the Vostok-3KA facility, agreed with V.V. Parin. The program, signed by E.A. Karpov, F.D. Gorbov, A.R. Kotovskaya and I.T. Akulinichev, provided for daily medical observation in the pre-launch period, and the results of research and observations to be recorded in a special journal and recorded in the medical books of cosmonauts.

The medical examination included a medical examination and maintenance. The physical examination included an assessment of well-being and measurement of pulse, arterial blood pressure and physical examination (palpation, percussion and auscultation). The medical examination was entrusted to A.V. Nikitin, F.D. Gorbov and A.R. Kotovskaya. Medical care included the registration of an electroencephalogram, an electrocardiogram and a vector cardiogram, the evaluation of data from a clinical analysis of blood and urine, an examination by a therapist and a psychoneurologist. This part of the medical examination was entrusted to I.T. Akulinichev, F.D. Gorbov and A.V. Nikitin [14]. On the evening of April 11, a pre-flight medical examination of Yu.A. Gagarin and G.S. Titov was carried out, and electrodes were applied and recorded for recording physiological parameters in flight.

Early in the morning of April 12, 1961, the cosmonauts were taken by bus to the launch pad. A short report was made to the Chairman of the State Commission. At the top of the spacecraft at this time was A.D. Seryapin, who, while waiting for the cosmonaut, checked the readiness of the spacecraft's life support system to connect his spacesuit. After the inspections, A.D. Seryapin went down and did not go upstairs. At the elevator, during the ascent and at the hatch of the spacecraft, Yu.A. Gagarin was met and accompanied by L.G. Golovkin, O.G. Iva-novsky, F.A. Vostokov and cinematographer V.A. Suvorov. Then O.G. Ivanovsky and F.A. Vostokov took an elevator with Yu.A. Gagarin to the upper platform of the launch vehicle service truss to the Vostok spacecraft, helped

him get into the ship, sit in the chair and closed the hatch. There was 1 hour and 7 minutes left before the start.

In the command bunker during the launch were S.P. Korolev and V.I. Yazdovsky at the emergency engine shutdown console, N.P. Kamanin and L.A. Voskresensky, A.S. Kirillov, who gave the command "Start!", and B.S. Chekunov, who pressed the "Start" button. P.R. Popovich was there and maintained voice communication with Yu.A. Gagarin, whose call sign was "Kedr". At 9:07 a.m. on April 12, 1961, in response to the command "Rise!" Yu.A. Gagarin uttered the phrase that became known to the whole world: "Let's go!".

For the first time in the history of mankind, the Vostok spacecraft was launched to perform an orbital space flight by cosmonaut No. 1 of planet Earth Yu.A. Gagarin. The condition of Yu.A. Gagarin in flight was assessed with the help of the vega-A medical complex, which provides registration of the electrocardiogram and respiratory rate of the cosmonaut and data transmission to Earth in communication sessions. The radio channel continuously transmitted audible pulse signals. After orbiting the Earth at 108 minutes at 10:55 p.m., the spacecraft completed the flight one second earlier than planned. Due to a malfunction in the braking system, the descent vehicle with Yu.A. Gagarin landed not in a given area, 110 km from Stalingrad, but near the village of Smelovka near the town of Engels, Saratov Region.

At 10:48 a.m., an unidentified target appeared on the radar of a nearby military airfield, which split into two marks as it descended. It was a lander, from which, at an altitude of 7 km, Yu.A. Gagarin ejected for descent by parachute. His flight lasted 1 hour 48 min. For his great contribution to the preparation and implementation of the space flight of Yu.A. Gagarin, the State Research Test Institute of Aviation and Space Medicine was awarded the Order of the Red Star, and 92 of its employees were awarded state awards. In the future, the Institute was engaged in the preparation and medical and biological support of flights of G.S. Titov, A.G. Nikolaev, P.R. Popovich, V.F. Bykovsky and V.V. Tereshkova [15].

The flight of Yu.A. Gagarin proved the validity of the methodology proposed by the specialists of the State Research Testing Institute of Aviation and Space Medicine for the selection, formation of a plan and implementation of the program for training students of the Air Force Cosmonaut Training Center for Space Flight. Medical, psychological and psychophysiological support of the flight was an integral part of ensuring the safety of the flight of Yu.A. Gagarin. On April 22, 1961, Yuri Gagarin met with employees of the State Research Testing Institute of Aviation and Space Medicine, at which he shared his impressions of the flight and assessed the effectiveness of medical and psychological preparation for the flight and the participation of the Institute's employees in it.

By the resolution of the Central Committee of the CPSU and the Council of Ministers of the USSR of October 28, 1963, the Institute of Space Biology and Medicine was established, which in 1965 became the Institute of Medical and Biological Problems of the Ministry of Health of the USSR. Its staff was largely formed from employees of the State Research Institute of Aviation and Space Medicine. Subsequently, these organizations worked closely together in space-related research under the Voskhod, Soyuz, Salyut, Almaz, Mir, Buran and International Space Station programmes.

Employees of the State Research Institute of Aviation and Space Medicine developed a system for preventing the adverse effects of weightlessness on the body of orbital station crews. Sanitary and hygienic parameters of the environment and operating conditions were determined in the interests of improving the efficiency and ensuring the safety of cosmonauts. They created methods and means of training to improve efficiency in flight, selected modes of work and rest of astronauts, developed methods for preventing fatigue and means of active rest in flight.

A significant result of the research was the creation of a system of comprehensive accounting of psychophysiological characteristics, capabilities and abilities of a person in the development and operation of aviation and space technology. It is based on the methodology of psychophysiological analysis and a systematic representation of the content, structure and mechanisms of regulation of activity, evaluation of algorithms, means and working conditions and taking into account the psychophysiological characteristics of the human operator. Research and work of scientists of the Institute became the basis for the creation of a state system of ergonomic support for the development and operation of weapons and military equipment.

The system operated on the basis of an approved ergonomics manual. Today, the safety of space flights largely depends on taking into account the psychophysiological characteristics and capabilities of a person in the creation of space technology and

the implementation of space flights. To do this, it is necessary to develop an experimental base and research methodology, train personnel, form and support scientific schools and create conditions for the exchange of views on topical issues of ensuring the psychophysiological reliability of astronauts.

Space exploration is the result of research, discovery, development and selfless work of many scientists and specialists. Current and future generations can and should be proud of the fact that at the beginning of these studies there were scientists whose thoughts determined the directions of practical human exploration of outer space. The generation of new ideas and the awakening of the creative potential of society is the destiny of individuals who are ahead of time, thinking on a large scale and brightly. They change the philosophy of life, help to gain a perspective of development, outline goals, objectives and directions of research and human progress. With regard to the exploration of outer space in the history of mankind, there are such personalities. These also include K.E. Tsiolkovsky, S.P. Korolev and V.I. Yazdovsky [16].

In connection with the development of space activities, their views on the exploration of outer space deserve special attention. The philosophical views of these scientists characterize the main stages of space exploration. These are the stages of conceptual ideas about the possibility of life in outer space, the conceptual application of ideas and solutions for interplanetary flights, the practical implementation of technical ideas and solutions for entering space, ensuring the safety of human work and life in space, creating conditions for a long stay and life in space conditions and determining the strategy for life and space activities of human civilization. One of the goals of space activities is the preservation and development of human life within the ever-wider boundaries of natural conditions through scientific, technical and social progress, including the personal improvement of each person.

The realization of this goal involves the resettlement of people to other planets. Real opportunities for this in the long term are laid down in the aerospace innovation process. The conquest of space heights and the exploration of outer space is the result of research, discoveries, developments, selfless work of many scientists and specialists. Progress along this path is becoming more complex and responsible, requires the integration of efforts, the pooling of material resources, the integration of the intellectual potential of specialists from many countries. However, the current and subsequent generations can and should be proud of the fact that at the beginning of this path there were domestic scientists whose thoughts determined the directions of practical human exploration of outer space. The content of the views of K.E. Tsiolkovsky, S.P. Korolev and V.I. Yazdovsky at these stages deserve to be studied and practically taken into account in the implementation of the strategy of space activities [16].

The day of the triumph of Russian cosmonautics, when a spacecraft with a man on board was launched into Near-Earth orbit, is going down in history. But the name of Yuri Alekseevich Gagarin, the first cosmonaut of the planet, is known in all corners of our country and abroad [8]. Gagarin's flight became possible thanks to the designers, engineers and technicians who created the spacecraft, and specialists who provided medical and biological training and flight safety.

On the basis of the foregoing, it is possible to formulate the following final clauses and conclusions.

Space exploration is largely related to the research of the staff of the Research Testing Institute of Aviation Medicine, who laid the foundations for medical, technical and psychophysiological support for the preparation and implementation of the first manned space flights. The research of the Institute's staff of that period can rightly be considered pioneering developments. This applies to the justification of the pressure regime in the pressurized cabins and protection against explosive decompression during depressurization of the cabin, breathing under excessive pressure for flights at all altitudes, the creation of a space suit and means of ejection and landing by parachute. The indisputable merit in conducting medical and biological training of a manned space flight rightfully belongs to Vladimir Ivanovich Yazdovsky.

Under his leadership, medical and technical requirements for the life support system in the cockpit of the spacecraft and ensuring flight safety were developed. The selection and training of cosmonaut students for the orbital space flight was ensured by conducting medical, psychological and psychophysiological studies, tests and training. The selection of an ad hoc group of six astronaut trainees from the selected 20 candidates made it possible to carry out research, tests and training in the planned amount and to complete the training in a timely manner and at the

required level. In the process of testing and training, all members of the special group showed the required level of tolerance by the body of the effects of the expected factors of space flight.

The examinations revealed a high degree of readiness of all students-cosmonauts of the special group to perform a space flight. Based on the results of the consideration of personal files, flight books, educational cards, service characteristics, data from clinical and physiological examinations, tests and training, as well as physical condition, the members of the examination commission tentatively determined the priority sequence of candidates for the first space flight. This sequence was the basis for the decision to approve the candidacy of Yu.A. Gagarin for the first manned space flight.

Space exploration involves conducting systematic research to study the influence of factors of interplanetary expeditions on the health, functional state, performance and professional reliability of astronauts. The effectiveness of such a study is ensured by the purposeful conduct of fundamental, exploratory and applied research on the study, generalization, analysis and assessment of the capabilities, characteristics and abilities of a person in the creation of space technology and the organization of professional activities of astronauts.

The author notes the special merits of the founder of domestic space medicine V.I. Yazdovsky in the preparation and implementation of space flight Yu.A. Gagarin.

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