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Actual Human Factor Problems of the Implementation of Manned Spaceflights

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ABSTRACT

The article is devoted to the analysis of materials of the 13th International Scientific and Practical Conference "Piloted Flights into Space" in terms of the problems of taking into account the psychophysiological characteristics, capabilities, and abilities of a person in the implementation of the domestic space strategy. Assessments by the conference participants of the condition and prospects of increasing psychophysiological reliability of cosmonauts are given by medical-technical and socio-psychological support of training and assessment of their readiness for flights and maintenance functional state in flight. There are achievements and problems of analysis and evaluation of psychophysiological reliability of cosmonauts to develop recommendations to ensure flight safety and prevention of the negative impact of weightlessness on the body of astronauts. Promising areas of research to maintain the performance of cosmonauts in the implementation of interplanetary flights are shown. Final provisions and conclusions on the need for systemic research to take into account the psychophysiological characteristics, capabilities, and abilities of astronauts to ensure their professional reliability and spaceflight safety.

INTRODUCTION

The 13th International Scientific and Practical Conference «Piloted Space Flights» were held at the Russian Y.A. Gagarin Cosmonaut Training Center, on November 13-15, 2019 [1]. Russian cosmonauts Alexander Skvortsov and Oleg Skripochka congratulated the participants on the opening of the conference. The conference participants discussed the actual problems of space activities and the training of cosmonauts for flights and interplanetary expeditions. Traditionally, research results have been analyzed and evaluated, and prospects for the implementation of the space strategy have been determined [2].

In the report of V.N. Vlasov and Y.I. Malenchenko «Yu.A. Gagarin Research&Test Cosmonaut Training on the eve of his 60th birthday» there were noted that thanks to the scientists and specialists of the center in the country formed a domestic system of selection and training of cosmonauts for the flights on manned spacecraft of a different class. About 600 cosmonauts and astronauts have been prepared for space flights. Piloted cosmonautics has evolved, embodying the advanced achievements of world science and technology. The scientific and methodological basis for scientific research is developing. A system has been created to training crews outside the spaceship activities and to assemble large structures in orbit.

In the report, presented by A.A. Kuritsyn and Y.S. Chebotaryov, there were analyzed the prospects for the development of world cosmonautics. It was noted that manned space development programs were of important political and social significance. The use of the International Space Station has brought together the efforts of 16 states in space exploration. Work is underway to create a new generation of manned ships, interplanetary tugs, and heavy launch vehicles. In the development of missions to the Moon, asteroids, and Mars, new factors and dangers must be taken into account to ensure flight safety and manned space development programs.

Analytical part

The conference focused on taking into account the psychophysiological characteristics, capabilities, and abilities of cosmonauts to ensure their professional reliability and flight safety [3]. The need for such accounting in the design and exploitation of space specimens is explained by the ability to improve the reliability of the professional activities of cosmonauts,

and ensuring of timely perception of information, training and decision making, and prevention of erroneous and untimely actions.

The methodology of developing cosmonauts' means and technologies with taking into account their psychophysiological characteristics, capabilities, and abilities, is particularly actual in connection with the preparation and implementation of long and interplanetary missions. A principal important feature of this methodology is its focus not only on improving the efficiency and safety of flights but also on maintaining a functional state, health, professional motivation, and personal development [4].

Taking into account the human factor in the interests of spaceflight safety involves ergonomic support for the creation and exploitation of space specimens, optimization of means, algorithms, and conditions of professional cosmonauts activity and the formation and maintenance of their performance in flight [5]. The organizational and methodological foundations of the systemic accounting of human capabilities in aviation and space have been developed with the active participation of specialists of aerospace agencies and organizations, including the Y.A. Gagarin Cosmonaut Training Center [6]. Ergonomic accompaniment to the creation and operation of aerospace specimens has shown its effectiveness in increasing the psychophysiological reliability of professional activities and flight safety.

The basis of accounting for the psychophysiological characteristics, capabilities, and abilities of cosmonauts to ensure the reliability of activities and prolong professional longevity of cosmonauts is the psychophysiological analysis of the structure and content of activities in terms of expected in future conditions and circumstances of long orbital and interplanetary expeditions [7]. Such analysis also involves generalizing, systematizing, and assessing changes in the functioning of the body in weightlessness and identifying features, specifics, difficulties, problems, and erroneous actions in the process of activity and saving of skills, assessment of the situation and decision-making. Materials of psychophysiological analysis of activities are used for ergonomics optimization of means, algorithms of activity and working conditions of cosmonauts, as well as systems of selection, training, assessment of functional status, increasing of performance and prolonging of professional longevity.

Psychophysiological analysis of activity allows substantiating the indicators and criteria of assessment of the readiness of the cosmonaut to perform the flight mission and determination

the requirements for stands and simulators used for professional training and enhancement of the body's resilience to the action of space flight factors [8].

In L.M. Korolev's report «Ergonomic requirements for the characteristics of the system cosmonaut - space technology - professional environment of activity» there were named the problems of ergonomic expertise and evaluation of the compliance of means and algorithms of cosmonauts'work requirements of ergonomics. Particular attention was paid to the ergonomic optimization of the processes of perception and transformation of information and implementation of executive and management actions by taking into account the human capabilities and specimen of technics in the interests of providing the professional reliability cosmonauts in space flight. At the same time, the importance of a systematic approach to justifying ergonomic requirements for means of activity was noted [9].

To perform work outside the spaceship abroad and in domestic cosmonautics, it is planned to use robotic complexes and systems [10]. In the development of research of this direction in the report of V.G. Sorokin, there were examined information processes of interaction of the cosmonaut with the robot in copying mode with the help of a specific device, put on the cosmonaut [11].

This device allows you to remotely control the manipulations close to the motor skills of the movements of the hands and fingers of humans. A.E. Spirin, A.I. Krylov, A.A. Skvortsov, and E.A. Spirin noted the importance of ensuring the interoperability of human-operator with an anthropomorphic robotic system, which should ensure the accuracy of copying actions, positioning, and activities based on the tactile sensitivity inherent in humans. In this regard, the technology is being developed to design tactile-kinesthetic characteristics of the limbs of the anthropomorphic robot based on multimodal integration of channels of perception and to ensure completeness of information about the position and movement of parts body in space, taking into account the subject environment and mutual negotiation alignment of sensory and motor components of the actions of the anthropomorphic robot.

Practical interest among the participants of the conference was caused by the message of A.A. Kuritsyn, V.N. Dmitriev, V.A. Dovzhenko, V.G. Sorokin, E.V. Nikitov and Y.S. Chebotaryov about the results of the preparation and performance of the space experiment «Tester» onboard International Space Station. A computer stand of robotic

systems has been created to work out the interaction of cosmonauts with anthropomorphic robotic systems in copy mode during standard flight operations.

In the course of the space experiment, the scenarios of the robot's operation in automatic mode and the operation in the copying control mode on the use of a normal tool have been worked out. In the future, the anthropomorphic robot is planned to be used to perform work on the outer surface of the International Space Station and technological operations in the development of deep space. A.A. Pronin and I.B. Prokhorov stopped in more detail of the scientific aspects of the space experiment «Tester». In particular, they stopped on the features of copying control anthropomorphic robots. With its helping it's possible to fulfill a variety of actions in non-deterministic conditions in which the copying type of control is most effective. This is provided by the formation of control actions on the results of copying the operator's actions. Based on the results of the first phase of the space experiment, there was a justified conclusion about the feasibility of using the developed management interface, taking into account the requirements of ergonomics and psychophysical laws of feedback. In this regard, E.M. Kuznetsova, A.A. Trusts, M.Yu. Guk, A.V. Sergeyev, and I.Y. Daliaev assessed the prospects of using a seven-step specific device to control the robotic complex. They noted that its use expands the range of tasks of servicing spacecraft and conducting research on planets. This device allows you to shape and implement actions of a complex trajectory, including capture and other actions, taking into account the efforts applied.

E.V. Nikitov, Yu.S. Chebotarev, B.I. Kryuchkov, V.M. Usov, V.N. Dmitriev, V.G. Sorokin, and V.A. Dovzhenko studied the specifics of the management of space robotic systems about lunar conditions. They noted increased interest abroad in the use of a group of robots to solve complex and interconnected tasks and reduce the cost of robot resources while improving the reliability of actions and informative signals about their effectiveness and problems. However, there is appeared a need to identify tasks that require the involvement of a group of robots to successfully solve them and restrictions on the implementation of certain functions and actions by robots.

In this regard, various ways of cosmonauts control a group of robots was considered and evaluated and the requirements for their appearance, functional opportunity, and control channels were substantiated. The study was conducted using a universal computer stand of robotic systems. The development of the method of preparing cosmonauts for the management of anthropomorphic robots using this stand was been reported in the report of

Y.S. Chebotaryov. He noted that the method of preparing cosmonauts for the management of an anthropomorphic robot in a TV-controlled copying mode corresponds to the strategy of development of Russian manned cosmonautics, which provides for the use of robotic systems for supporting of cosmonauts in orbital flight conditions. The results of the approbation of the method allow us to move to the stage of development of the system of control of robotic systems and assessment of the readiness of cosmonauts for their effective use for purpose tasks.

I.G. Sokhin, E.A. Dudorov, and E.V. Rybak summarized the goals, objectives, and prospects of space experiments using robots. In their opinion, the development of a promising manned infrastructure provides for robotic support of crews in orbital flight conditions and on the surface of the Moon. Therefore, they consider the conduct of space experiments using robots and other spacecraft to be a relevant and promising direction for the creation of a future-based scientific and technical foundation for the development and effective application of robotic-assistants of cosmonauts in interplanetary space missions. There were received data on the characteristics of control of the anthropomorphic robotic system by cosmonaut in the conditions of weightlessness, unsupported space and radiation, and electromagnetic influence. In the sequel of the experiment «Tester» is planned to conduct a space experiment «Teledroid» in open space. Further research in this area involves the development, creation, and experimental use of robotic-assistants of cosmonauts in the system of habitable or visitable of orbital stations and bases on planets.

V.P. Khripunov, B.A. Naumov, and Yu.B. Sosyurka outlined their vision of problems of innovative development and the creation of technical means of training cosmonauts. There were considered directions of development of manned cosmonautics related to the completion of the deployment of the Russian segment of the International Space Station and the possibility of exploitation of the Russian orbital station, with the creation of a prospective manned transport system and space infrastructure and technologies for manned flights to near-moon space and the Moon. There was substantiated the need to realize a single scientific and technical policy and a comprehensive systemic approach to adapting the existing system of training cosmonauts for the implementation of new space programs, creation and modernization of the technical means attracted to cosmonaut training. There was marked the need to create, implement, and use of new learning technologies and intelligent support for learning processes, computer training programs, information, and didactic complexes,

training databases, and knowledge databases. In continue of these provisions, B.A. Naumov and V.P. Khripunov outlined the concept of creating a multifunctional training complex to train cosmonauts to perform flight programs on all types of manned spacecraft. In their view, the composition, quantity, and methods of creation of technical means should provide the proper level of training with the optimal ratio of the «efficiency-cost» criterion. This takes into account the duration of operation of the complex of technical means of training cosmonauts, the increase in the composition and technical complexity of simulators, organizational and technical problems of ensuring the timeliness of development. This task decides to need an interconnected consideration of the training needs of astronauts, the technical possibilities of creating new training means, economic, technological, and production resources and limitations.

A.I. Kondrat, G.D. Oreshkin, A.S. Kondratiev, A.I. Shurov, A.Yu. Savintsev and Yu.A. Klyuev analyzed the features of manual control when performing modes of rapprochement, approaching and docking on a specialized simulator «Don-Soyuz». They noted that during training cosmonauts show individual management styles, which are not taken into account when assessing the level of preparedness for manual rapprochement, approaching, and docking. In this regard, the features of the individual style of action of cosmonauts were studied for taking when assessing their readiness. Testing of the method of taking into account the individual style of manual control when performing modes of rapprochement, docking, and docking allowed to clarify indicators and criteria of assessing the actions of cosmonauts during their training on the simulator.

S.P. Suprun and L.E. Shevchenko reported on the experience of developing and operating the simulator complex modules of the Russian segment of the International Space Station. The simulators of the complex belong to human-machine systems in which training, engineering, and medical personnel are included in the control and management of the training process. During the design, development, and testing phases of the simulators, special attention was paid to meeting the requirements of ergonomics, which ensure the creation of adequate information models of activity, as well as the safety and comfort of operators. Training is the main type of work in the exploitation of complex simulators. In training in the full configuration of the simulator, complex simulates the work of the orbital complex under the program of daily-night flight.

A.R. Bikmuchev presented the materials of the analysis of the reasons for deviations in the management of the «Soyuz-MS» manned transport spacecraft during complex pieces of training on the simulator. Following the existing methodology for assessing the preparation of crews for the management of a manned transport ship, one of its indicators is the degree of deviation from the established normative values. However, the causes of such deviations have not been considered or analyzed. In this regard, it is proposed to classify deviations from normative values to determine the causes of their occurrence to reduce their likelihood of appearing during training and in space flight.

G.D. Oreshkin, V.G. Korzun, A.I. Kondrat and A.I. Shurov presented materials to determine the competences of cosmonaut training specialists. In their opinion, the professionalism of a specialist in the training of cosmonauts includes his ability to self-educate and self-development and purposeful formation of the necessary qualities for this. Significant for these specialists are professional and educational competence, based on a combination of technical-technological and psychological-educational knowledge, skills, and skills. In their opinion, the emphasis is now on professional engineering competences, so they believe it is necessary to achieve a balance of professional-educational and vocational-engineering competences. In this regard, it is proposed to pay special attention to the formation of professionally important qualities and personality characteristics of psychological and educational orientation.

I.B. Solovyov and V.N. Dmitriev reported on the problematic issues of preparing cosmonauts for promising flights. In the flight of transport spaceship next-generation for service near-Earth stations, there is increase the probability of exposure to factors, connecting with the new design solutions for equipment layout, instrumentation and software equipment of the spaceship, launching of rocket-vehicle from the spaceport «East» and the fulfilling of landing and evacuation of space crews in new areas. The Lunar program creates new tasks, technological operations, and flight conditions, including autonomy at its stages. The novelty of factors and conditions of flight affects both the reliability of the operation of the technique, and the psychophysiological state and performance of cosmonauts, especially in extreme conditions. In this regard, the requirements for training crews of prospective spacecraft and their professional and psychological readiness for autonomous effective and safe activities in extreme flight conditions are increasing.

O.V. Blinov and A.A. Guselnikov considered approaches to the development of a comprehensive simulator of a manned transport ship of the next generation. They noted that the simulators of manned transport ships provide training and practical lessons of cosmonauts to control systems and spacecraft, including work in spacesuits in regular and emergencies, with imitation of the work of all on-board systems, monitoring and recording of crew actions during the preparation of flight stages. The development of simulators requires significant material and financial resources and attracting and coordinating the efforts of highly qualified professionals of different profiles. The concept of building a new generation integrated spaceship simulator is based on practice-tested organizational and technical solutions. This allowed justifying the requirements for the comprehensive simulator and justifying the need for its development at the same time as the creation of a new manned spacecraft.

M.M. Kharlamov, A.A. Kuritsyn, B.I. Kryuchkov and V.A. Kopnin reported on the results of the assessment of the astronauts' capabilities to solve the tasks of professional activities in deep space. They noted that in long-term space flights under the influence of weightlessness and other factors change the characteristics of operator activity and the ability of astronauts to perform various works. To carry out space flights to the Moon and the planets of the solar system, it is necessary to take into account the possibilities of performing a flight mission by cosmonauts in the conditions of gravity of these planets after long exposure to weightlessness. As typical tasks of operator activity and control of space objects on the surface of planets are considered manually controlled descent to the surface of the planet, manual mooring mode, conducting the off-spaceship activities and working with complex technical systems. In this regard, it is envisaged to explore the possibilities of solving the operator's tasks of different complexity by crew members after long flights to develop recommendations for similar work on the surface of the Moon and the planets of the solar system.

P.P. Dolgov, I.N. Gavrik, and E.Yu. Irodov conducted a stage analysis of lunar expeditions for simulation on centrifuges. In their analysis, they proceeded from plans to prepare a test flight and dock a lunar landing complex with a manned spacecraft, land on the moon without a crew, and the subsequent manned flight and landing on the moon of cosmonauts with a two-week stay. On the Moon, the crew will be in conditions of reduced, compared to the Earth's, gravity. The centrifuge allows you to simulate the lunar conditions of reduced weight, as well as all the values of overload on the dynamic stages of the lunar expedition

flight. In this regard, the need to prepare cosmonauts for the expedition to the Moon using centrifuges, modeling dynamic stages of flight, and the activities of cosmonauts in the management of spacecraft is justified.

O.O. Ryumin's report was devoted to psychophysiological issues of selection and training of commanders of interplanetary expeditions. Due to the increase in their responsibility for the performance of the flight mission, including in conditions of autonomy, there was marked a need to justify the requirements for the qualities, properties, and characteristics of the commander's personality. The qualities that are recommended to pay attention to when appointing the commander of the interplanetary expedition and preparing it have been defined. In addition to the formation of the physical, physiological, operator, personal, intellectual, and organizational qualities, the need is marked to remain performance in the conditions of monotony, nervous-emotional tension, and chronic fatigue, as well as psychophysiological readiness to act in emergencies.

P.A. Saburov and E.V. Popova considered the development of a complex of functional-modeling stands to training cosmonauts for scientific and applied research and experiments. Training of cosmonauts is provided with using technological samples of equipment, presentations, and on-board documentation and includes the formation of skills to conduct experiments using virtual reality equipment. Demonstration, training, and exam modes are implemented on the virtual simulator. This is accompanied by monitoring of actions and displaying relevant information on the screen. The experience of preparing cosmonauts for experiments using virtual reality equipment allows it to be recommended for use for the implementation of all programs of space research and experiments.

A.V. Koshenka reported on the need to improve the observation equipment and automation of visual and instrumental observations and monitoring of the earth's surface to obtain reliable information about the natural and ecological state of the terrestrial objects in live-shooting mode. Observations of Russian cosmonauts make a significant contribution to solving the problems of remote sensing of the Earth. Recently, however, the requirements for the results of space monitoring of the Earth's surface in terms of spatial resolution, visibility, frequency, and speed of information are increasing. This necessitates the improved performance of observation equipment and visual and instrumental observations with enhanced capabilities to solve the task of environmental monitoring of ground-based sites. V.E. Fokin, N.V. Vasilyeva, E.V. Dedkova, S.N. Maximov, and E.S. Yurchenko developed a

method of assessing the preparation of candidates for cosmonauts to conduct visual and instrumental observations on a special simulator. Training allows you to form and evaluate the skills of detection and recognition of ground-based sites and typical objects of the region, as well as abilities to decrypt, link to landmarks, and conduct professional radio reports. Taking into account the importance of preparing cosmonauts for visual and instrumental observations, V.I. Vasilyev, N.V. Vasilyev, D.A. Bondarev, and E.S. Yurchenko prepared technical solutions for the modernization of the stand. They noted the actuality of the band expansion to ensure the adequate perception of observed objects on the earth's surface. Their proposed technical solutions for displaying the external visual environment in the form of a video wall allow create conditions for observation of the earth's surface with the resolution, adequate observation conditions from the International Space Station and improve the effectiveness of astronaut training and use of scientific equipment.E.V. Dedkova, E.S. Yurchenko, S.N. Maximov and V.E. Fokin summarized the experience of training flights on visual-instrumental observations on the Tu-134LK laboratory aircraft to study the physical and geographical characteristics of the observation regions and sites adjacent areas, as well as the identification of areas for inclusion in the program of scientific and applied research onboard the International Space Station. The result of such flights was the conduct of space experiments and the identification of new regions for visual and instrumental observations of Russia's natural zones.

A.O. Savinkina, K.A. Shef, V.I. Gushchin, S.V. Poddubko, and A.N. Agureev reported on the need for an individual approach to the catering of participants in long-term isolation experiments. Based on the data of the insulation experiment, they identified an assortment of products that could form the basis for creating a diet of nutrition compliance with the standards of content components and their energy value needed to cover energy spending. Further direction of research on the development of individual feeding regimes for crew members taking into account the sex, age, weight, and consumption of physical energy, as well as changes in taste preferences and motor activity of crew members, are substantiated.

I.V. Kutina and A.N. Agureev presented data on the basic energy parameters of the acoustic environment in the inhabited compartments of the International Space Station and the noise load of Russian cosmonauts to assess their compliance with regulatory values. For hygienic rationing of the effect of noise on crew members is asked to consider the possibility of cumulating its effects. L.Y. Marchenko and E.E. Sigaleva reported on the prospects of using

artificial breathing mixtures of oxygen for noise protection. Noise from the station's working equipment poses a threat to the hearing of cosmonauts in a long space flight. In this regard, it is proposed to use inert gases to prevent and treat the effects of noise exposure. Experimental studies show the feasibility of using breathing mixtures of gases to prevent the development of hearing disorders in astronauts during long space flights.

S.N. Harlashkin noted the need to prepare cosmonauts for off-spaceship activities when flying to the Moon, Mars, and asteroids using experience and programs of formation the skills of performing typical operations in the conditions of short-term weightlessness. In the case of planetary works, it is considered to work out such actions as the ascent and descent on the ladder, including the container, moving steps and jumping on a flat or sloping surface, moving on uneven surfaces with obstacles, assembly and installation operations and others. The short-term weightlessness mode on the laboratory aircraft allows you to reproduce modes with residual overloads corresponding to lunar and Martian gravitational modes. The report considers proposals on the methodical aspects of the organization and training of cosmonauts in the development of typical operations of off-ship activity with the reproduction of short-term weightlessness modes on a laboratory aircraft.

A.A. Altunin and N.R. Jamaletdinov drew attention to the development of spacesuits and means of providing off-spaceship activities on the surface of the Moon at the same time as the creation of lander modules. Based on the analysis of micro-relief and soils on the surface of the Moon, there were justified requirements for the composition and characteristics of the spacesuit and means of providing exit, there were defined the tasks of training cosmonauts to exit on the surface and the list of operations and actions of ensuring.

G.M. Glazov, S.S. Pozdnyakov, S.N. Filipenkov, A.D. Shibalov, and G.V. Schavelev reported on the development for the spacesuit «Orlan-ISS» the system of thermoregulation of cosmonaut's thermal status and outlined the results of ground testing of its application. The proposed method of automatic temperature control of a refrigerant in a water cooling suit excludes the delayed or erroneous response of the cosmonaut to the change of the level of physical activity during the process of activity outside the spaceship.

A.S. Kondratiev, A.E. Malikov, and P.V. Pirogov noted that the complexity of manned space missions involves effective interaction between crews and ground control services. Specialists who provide communication with crew members have a special responsibility,

both for the content of the dialogue and for the psychological support and emotional mood of the crew [12]. In this regard, recommendations have been made for communicating a crew member with each other both in regular flight operations and activity outside the spaceship and in case of emergencies. Supporting communication with accounting these recommendations have repeatedly contributed to the crew's effective mission performance and the exclusion of erroneous and untimely action.

S.I. Pototskii, A.G. Dushenko, V.I. Stanilovskaya, A.M. Belyaev, and O.I. Lakhin drew the conference's attention to the problems of information support for crews and specialists of the Main-group of operative control of flight in case of emergencies. They noted that modern information technology made it possible to enhance the ability of flight control and support systems and efficiently using equipment and to obtain the information needed for decision-making. In connection with the preparation of astronauts' flights to the Moon and Mars in the absence of communication of the crew with the Earth is developing a version of autonomous flight planning onboard the spacecraft. It provides the accounting of the number of planned operations, the degree of loading of crew members during the implementation of plans, the duration of flight operations, the temporary relationship between flight operations, as well as the training of crew members to carry out appropriate operations. A.G. Dushenko, V.N. Kryvchun, S.S. Ogurtsov, and A.L. Morokovconsidered the problems of creating an adaptive simulator to form or restore the skills of situational support of shift flight managers and specialists of the Main-group of operative control in case of accidents in flight. In the development of the simulator provides a function of quantifying the correctness of the actions of specialists. The simulator simulates the state of the equipment and environment parameters on the Russian segment of the International Space Station, the reaction to the actions of crew members and specialists of the control group, that is be reflecting on the frames of telemetry information in the cases of depressurization, fire, the appearance of toxic substances in the atmosphere and other emergencies.

In the report of V.I. Pochuev, R.R. Kaspransky, and V.P. Matveyevthere have identified the main directions of development of the selection system, biomedical, physical and psychological training, and medical support for professional activities and post-flight rehabilitation of cosmonauts.

DISCUSSION

To ensure of the professional activities of cosmonauts in perspective space programs there is planed research of human capabilities in space flight based on modeling the conditions of spaceflight and exploitation of planetary bases, assessment of human health, creation of a system of collecting, storing and processing of medical information about the health of cosmonauts and reducing of risks for their health [13].

In this regard, there were noted the importance of development and implementation of the organizational and methodical основ basics of planning and conducting of research and space experiments.

First of all, this applies to studies of the effects of space flight factors on the human body and development of proposals for selection, biomedical training, and post-flight events to reduce adverse effects of space flight on the body of cosmonauts. The same applies to the justification for proposals to develop cosmonaut training means and methods based on the individualization of mental and physical activity in the preparation and implementation of flights [14]. The system planning of research applies no to less extent to the improvement of the means and methods of the ergonomic provision of activities outside the spaceship and on the planet and the rehabilitation system of cosmonauts in the process and after interplanetary flights [15].

SUMMARY

Based on the above, it is possible to formulate the following final provisions and conclusions.

At the 13th International Scientific and Practical Conference «Piloted Space Flight» were discussed the problems of human opportunity accounting to ensure the effective work of astronauts and their professional reliability in the implementation of long-term orbital flights and the development of deep space. Increased attention have been paid to improving spaceflight training and selection, professionally important qualities, psychophysiological reliability and restoration of functional status cosmonauts after spaceflight.

The problems of creating and developing a logistical and experimental base for research on the structure, content and specifics of the professional activities of cosmonauts in long-duration space flights were discussed. There were substantiated actuality of interdisciplinary

fundamental research on problems of health and safety of cosmonauts, and intellectual support for their autonomous activities in condition of stress factors exposure of interplanetary flights.

It is shown that taking into account the psychophysiological characteristics, capabilities and abilities of astronauts in order to ensure their performance, professional reliability and prolongation of professional longevity assumed the functioning of holistic system of engineering, psychological and ergonomic design of means and algorithms of cosmonauts' work, and socio-psychological, biomedical and psychophysiological support of their professional activities.

In this regard, in order to implement the domestic space strategy, it is necessary the coordination of inter-agency research and development on human factor accounting in the preparation and implementation of professional activities of cosmonauts and fulfilling research by science and educational organizations. It is noted the relevance of harmonization of the methodology of accounting for psychophysiological characteristics, capabilities and abilities of astronauts in the development of means and algorithms of activity and technical means of training cosmonauts in order to ensure their professional reliability, increased resilience to the action of weightlessness, maintaining performance and prolonging professional longevity.

To successfully implement the space development strategy, it is necessary to use the domestic experience of taking into account the psychophysiological characteristics, capabilities and abilities of cosmonauts in the design, testing and operation of on-spaceship systems and compartments, service, scientific, cargo and medical modules to optimize the algorithms, means and conditions of the cosmonauts' professional activities, plan and control the load and assess the functional status.

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