

CONTENTS

RESULTS OF THE ISS CREW MISSIONS.....	5
Main Tasks of Training and Results of Activity of the ISS Crew for Expedition 55/56 When Carrying out the Mission Plan. <i>O.G. Artemiev</i>	5
Medical Aspects of Ensuring Safety of the Flight of the ISS Crew for Expedition 55/56 (Express Analysis). <i>V.V. Bogomolov,</i> <i>VI. Pochuev, I.V. Alferova, E.G. Khorosheva, V.V. Krivolapov</i>	18
THEORY AND PRACTICE OF HUMAN SPACE FLIGHTS	32
Main Results of the Competitive Selection of Cosmonaut Candidates in 2017–2018. <i>P.N. Vlasov, Yu.I. Malenchenko, B.I. Kryuchkov,</i> <i>A.A. Kuritsyn, M.M. Kharlamov, VI. Pochuev, B.G. Korzun,</i> <i>VP. Matveev, R.R. Kaspransky, L.V. Voytulevich, A.V. Vasin,</i> <i>VM. Usov, V.Yu. Samartsev, A.S. Kondratiev, A.I. Krylov,</i> <i>V.G. Nazin, Ye.V. Andreev, A.D. Belyaeva</i>	32
Dynamic Simulation Model of Visual and Instrumental Observation of a Point Target by a Cosmonaut-Operator While Flying-By. <i>VM. Zhukov</i>	45
Problems of Adequacy of the Model Hypo Gravity of the Moon and Mars. <i>VA. Akulov, VL. Balakin</i>	62
Modern Approaches to the Assessment of the Effect of Artificial Light Environment on the Functional Status of a Human Operator in Tests Inside a Pressurized Chamber. <i>A.E. Smoleevskiy,</i> <i>O.M. Manko, Yu.A. Bubsev</i>	80
Decrease of Negative Effects of Mutagenic Factors on a Human Body Under Conditions of a Long-Term Space Flight. <i>E.V. Popova,</i> <i>I.V. Kutnik, A.I. Kobatov, N.B. Verbitskaya, O.V. Dobrolezh</i>	96
Prospects and Features of the Use of Inflatable Transformable Modules of Manned Space Complexes. <i>B.I. Kryuchkov, Yu.B. Sosyurka,</i> <i>B.V. Burdin</i>	114

UDC 629.78.007

Main Tasks of Training and Results of Activity of the ISS Crew for Expedition 55/56 When Carrying out the Mission Plan. O.G. Artemiev

The paper presents the members of the ISS-55/56 crew, main training tasks, activity of the crew aboard the Soyuz MC-08 spacecraft and the ISS. It also highlights the performance of EVA under the programs of the Russian and American Segments as well as the execution of scientific-applied research and experiments.

Keywords: crew training, spaceflight, manned transport vehicle, International Space Station, extravehicular activity, scientific program.

REFERENCES

Artemiev Oleg Germanovich – Hero of the Russian Federation, pilot-cosmonaut of the RF, test-cosmonaut, FSBO “Gagarin R&T CTC”

E-mail: info@gctc.ru

UDC 61:629.78.007

Medical Aspects of Ensuring Safety of the Flight of the ISS Crew for Expedition 55/56 (Express Analysis).

V.V. Bogomolov, V.I. Pochuev, I.V. Alferova,

E.G. Khorosheva, V.V. Krivolapov

Abstract. The paper shows the results of medical maintenance of the ISS-54/55 expedition and gives a brief description of operation of the medical support system and maintaining the stability of human environment aboard the ISS RS. Besides, the paper sums up results of implementing medical recommendations, program of medical monitoring and the use of onboard means designed to prevent the alteration of cosmonauts' health status in spaceflight.

Keywords: medical support, medical monitoring, preventive system, human environment, work/rest schedule.

REFERENCES

Bogomolov Valery Vasilievich – Doctor of Medical Sciences, Professor, State Science Center of the Russian Federation – Institute of Biomedical Problems of the RAS.

E-mail:

Pochuev Vladimir Ivanovich - PhD in Medical Sciences, Senior Researcher, Department Head-physician of the highest category, FSBO “Gagarin R&T CTC”.

E-mail: V.Pochuev@gctc.ru

Alferova Irina Vladimirovna – PhD in Medicine, leader of the mission medical support group, State Science Center of the Russian Federation – Institute of Biomedical Problems of RAS.

E-mail:

Khorosheva Elena Grigorievna – Senior Researcher, State Science Center of the Russian Federation – Institute of Biomedical Problems of the RAS

E-mail:

Krivilapov Vladimir Vsevolodovich – Senior Researcher, State Science Center of the Russian Federation – Institute of Biomedical Problems of RAS

E-mail:

Main Results of the Competitive Selection of Cosmonaut Candidates in 2017–2018.

P.N. Vlasov, Yu.I. Malenchenko, B.I. Kryuchkov, A.A. Kuritsyn, M.M. Kharlamov, V.I. Pochuev, B.G. Korzun, V.P. Matveev, R.R. Kaspransky, L.V. Voytulevich, A.V. Vasin, V.M. Usov, V. Yu. Samartsev, A.S. Kondratiev, A.I. Krylov, V.G. Nazin, Ye.V. Andreev, A.D. Belyayeva

Abstract. The paper represents the analysis of the results of the competitive selection of cosmonaut candidates held at the Yu.A. Gagarin R&T CTC in 2017-2018.

Keywords: cosmonaut candidate, open competition, cosmonaut selection, applicant for selection, selection stages.

REFERENCES

- [1] Krikalyov S.K., Kryuchkov B.I., Kharlamov M.M., Kotov O.V., Volkov S.A., Borisenko A.I., Pochuev V.I., Matveev V.P., Voitulevich L.V., Ren' V.A., Sokhin I.G., Koreshev I.V., Ryumin O.O., Samartsev V.Yu., Nazin V.G., Troitskiy S.S. Open Cosmonaut Candidate Selection Campaign in the Russian Federation in 2012 // Manned Space Flights. – No 1(10). – 2014. – pp. 29–40.
- [2] “International Agreements on Recognition of Academic Degree”, Ministry of Education and Science of the Russian Federation, Moscow. – 2009, p.103.
- [3] Order, Approved by the Government of the Russian Federation on December 30, 2015. No 2777-p «List of Foreign Educational Organizations that Provide Academic Certificates Recognized in the Russian Federation”, p. 22.
- [4] Professional Cosmonaut Selection. / Edited by Kryuchkov B.I., Kharlamov M.M. Yu.A. Gagarin Research & Test CTC. – 2009. – p. 209.
- [5] Vlasov P.N., Kuritsin A.A., Kryuchkov B.I., Kharlamov M.M. Selection to the Roscosmos Cosmonaut Corps in 2017–2018. /Proceedings of the XLV Social and Scientific Readings Dedicated to the Memory of Yu.A. Gagarin. – Gagarin City: Library Stock of Gagarin Memorial Museum, – 2018 (in press).
- [6] Malenchenko Yu.I., Kuritsin A.A., Andreev E.V. Results of the Open Cosmonaut Candidate Selection Campaign in 2017–2018. // Manned Space Flights.– No 4(39). – 2018, pp. 119–123.

Vlasov Pavel Nikolayevich – Hero of the Russian Federation, Head of the FSBO “Yu.A. Gagarin R&T CTC”

E-mail: info@gctc.ru

Malenchenko Yury Ivanovich – Hero of the Russian Federation, pilot-cosmonaut of the Russian Federation, First Deputy Head of the State Organization “Gagarin R&T CTC” for Cosmonaut Training

E-mail: info@gctc.ru

Kryuchkov Boris Ivanovich – Doctor of Technical Sciences, chief researcher, FSBO “Gagarin R&T CTC”.

E-mail: B.Kryuchkov@gctc.ru

Kuritsyn Andrey Anatolievich – Doctor of Technical Sciences, Associate Professor, Head of Department, FSBO “Gagarin R&T CTC”.

E-mail: info@gctc.ru

Kharlamov Maksim Maksimovich – Candidate of Economic Sciences, First Deputy Head for Innovative Development FSBO “Gagarin R&T CTC”

E-mail: info@gctc.ru

Pochuev Vladimir Ivanovich - PhD in Medical Sciences, senior researcher, Department Head-physician of the highest category, FSBO “Gagarin R&T CTC”.

E-mail: V.Pochuev@gctc.ru

Korzun Valeri Grigorievich – Department Head, FSBO “Gagarin R&T CTC”

E-mail: info@gctc.ru

Matveev Vladimir Petrovich – Deputy Head of the Department (for bio-medical training), FSBO “Gagarin R&T CTC”

E-mail: V.Matveev@gctc.ru

Kaspranskiy Rustem Ramilevich – Candidate of Medical Sciences, Deputy Head of the Department (for medical examinations), FSBO “Gagarin R&T CTC”

E-mail: R.Kaspranskiy@gctc.ru

Voytulevich Larissa Vladimirovna – Division Head–Therapeutist, FSBO “Gagarin R&T CTC”

E-mail: L.Voytulevich@gctc.ru

Vasin Aleksandr Vasilievich – Division Head–Neurologist, FSBO “Gagarin R&T CTC”

E-mail: A.Vasin@gctc.ru

Usov Vitaly Mikhailovich – Doctor of Medical Sciences, Professor, chief researcher, FSBO “Gagarin R&T CTC”.

E-mail: V.Usov@gctc.ru

Samartsev Byacheslav Yurievich – Division Head, FSBO “Gagarin R&T CTC”

E-mail: V.Samartsev@gctc.ru

Kondratiev Andrey Sergeevich - Division Head, FSBO “Gagarin R&T CTC”

E-mail: A.Kondratev@gctc.ru

Krylov Anatoli Ivanovich – Candidate of Technical Sciences, Division Head (chief metrologist), FSBO “Gagarin R&T CTC”

E-mail: A.Krylov@gctc.ru

Nazin Vladimir Georgievich – Candidate of Technical Sciences, Senior Researcher, FSBO “Gagarin R&T CTC”

E-mail: V.Nazin@gctc.ru

Andreev Yevgeny Viktorovich – Subdivision Head, FSBO “Gagarin R&T CTC”

E-mail: E.Andreev@gctc.ru

Belyayeva Anna Dmitrievna – Specialist, FSBO “Gagarin R&T CTC”

E-mail: A.Belyayeva@gctc.ru

UDC 629.78.072.8

Dynamic Simulation Model of Visual and Instrumental Observation of a Point Target by a Cosmonaut-Operator While Flying-By. V.M. Zhukov

Abstract. The computer-based dynamic simulation model (DSM) of visual and instrumental observation (VIO) of a point target by a cosmonaut using a panoramic observation device was developed. The DSM is the core model of the simulation models complex (SMC), which calculates the input parameters for it (current ballistic data of rendezvous and environmental parameters). The DSM is based on the hypothesis of the correspondence of the law of the distribution of points of staring to the normal two-dimensional law of the position of a point target in the ellipse of the probabilities of the forecasting position of a space object in orbit.

Keywords: detection probability, cosmonaut-operator, visual searching, point target, dynamic simulation model, visual analyzer, point of staring, prediction, graphic visualization, optimization.

REFERENCES

- [1] Alekseev Yu.V., Kushpil V.I., Petrova L.F. and others. Stochastic Model of the Operative Viewing Field // Proceedings of Vavilov State Optical Institute. – Vol. 3, Issue 20. – St-Petersburg: SOI Publ., 1988. – pp. 81–90.

- [2] Gippenreiter Yu.B. Human Eye Movements. – Moscow: MSU Publ., 1987.
- [3] Zhukov V.M. Scattering Diagrams of Scaled Models of Space Debris under Conditions of Solar-Laser Illumination // Manned Space Flights. – No 3. – 2017. – pp. 90–106.
- [4] Krasilnikov N.N. Theory of Transmission and Perception of Images. Theory of Image Transmission and its Applications. – Moscow: Radio svyaz Publ., 1986. – 246 p.
- [5] Kornilova L.N., Ekimovskiy G.A., Khabarova E.V., Glukhikh D.O. and others. Computer Method of Dizziness Objectivization and Differential Diagnostics of Vestibulopathy // Journal of Neurology and Psychiatry. – No 3. – 2015. – pp. 54–60.
- [6] Kravkov S.V. Eye and its Functioning. – Moscow – St.-Petersburg: Nauka Publ., 1950. – 531 p.
- [7] Lloyd J. Thermal imaging systems. – Moscow: Mir Publ., 1981.
- [8] Luizov A.V. Eye and Light. – St.-Petersburg: Energoatomizdat Publ., 1983. – 10 p.
- [9] Luizov A.V. Visual Inertia. – Moscow: Oborongiz Publ, 1961. – 28 p.
- [10] Optical Instrumental Complex OPK-51. Lightning design. – Kazan: GIPO Publ, 1981.
- [11] Rouz A. Human Vision and Electronic Vision. – Moscow: Mir Publ., 1978. – 216 p.
- [12] Rozhentsov V.V. Mathematical Model of Human Visual Analyzer // Sistemy upravleniya i informatsionniye tekhnologii Publ. – Vol. 21, No 4. – 2005. – 20–23pp.
- [13] Sukhanov A.G. Panoramic Astrophotography. – Moscow: Nauka Publ., 1985. – 88 p., il.
- [14] Travnikova N.P. Efficiency of Visual Search. – Moscow: Mashinostrieniye Publ., 1985. – 128 p.
- [15] Shibanov G.P. Quantitative Assessment of Human Activity in “Man-Technology” Systems. – Moscow: Mashinostrieniye Publ., 1983. – 263 p.
- [16] Virtual Space Experiment on the ISS URL: <http://www.mcc.rsa.ru/exp/virtual.htm> (accessed date: 12.01.2018).
- [17] Venttsel E.S. Operations Research. – Moscow: Sov. radio, 1972. – 551 p.
- [18] Electronic resource. URL: <https://www.vesti.ru/doc.html?id=2827267> (accessed date: 12.01.2018).
- [19] Klimuk P.I., Zabelina I.A. Gogolev V.A. Visual Observations and Contamination of the Optics in Space. – St.-Petersburg: Mashinostrieniye Publ., 1983. – 224 p.
- [20] Operator's Visual System and its Main Characteristics // Electronic resource – URL: <https://studfiles.net/preview/5065644/page/2/>.

Zhukov Vyacheslav Mikhailovich – Doctor of Technical Sciences, professor, chief researcher, FSBO “Gagarin R&T CTC”

E-mail: V.Zhukov@gctc.ru

UDC 681.51.012:531.5

Problems of Adequacy of the Model Hypo Gravity of the Moon and Mars.

V.A. Akulov, V.L. Balakin

Abstract. The methodology of indirect assessing the adequacy of the model hypo gravity of the Moon and Mars is proposed. The urgency of the problem is due to the tasks set in the national programs of deep space exploration (expeditions to planets) of a number of countries, the lack of the possibility of applying direct methods for assessing adequacy and expanding the scale of gravity therapy (treatment of ischemia). The short-radius centrifuges and inclined planes, that is, devices differing in the principle of action, were chosen as generators of hypo gravity what is important for indirect assessing the similarities and differences of models and real conditions. Earth gravity was chosen as the standard. The results of the experiments were compared with the regularities of hydromechanics and generalized by regression analysis methods. It has been established that the effect of hypo gravity and weightlessness on human peripheral hemodynamics is largely identical.

Keywords: model hypo gravity, model adequacy, short radius centrifuge, inclined stand, distributed four-pole element.

REFERENCES

- [1] G.I. Padalka, P.P. Dolgov, V.N. Kirshanov. Tasks of Training Cosmonauts on Centrifuges for Future Space Programs // Proceedings of the Space Forum-2011 Dedicated to the 50th Anniversary of Yu.A. Gagarin's Space Flight. – Gagarin Research&Test CTC, October 18–19, 2011.
- [2] P.P. Dolgov, V.N. Kirshanov, A.P. Chudinov. Main Directions of Operations on Centrifuges. Designated Use of Centrifuges. // Proceedings of the XI International Scientific & Practical Conference “Manned Space Flights” Dedicated to the 55th Anniversary of Yu.A. Gagarin Research&Test CTC, November 10–12, 2015. pp. 267–268.
- [3] O.G. Gizenko, A.I. Grigoryev, A.D. Egorov. From 108 Minutes to 438 Days and More...(to the

- 40th Anniversary of the Gagarin's Space Flight) // J. "Aerospace and Environmental Medicine". – 2001. – V. 35, No 2. – P. 10–11.
- [4] A.R. Kotovskaya, Vil' – I.F. Williams, V.Yu. Lukyanyuk. Issue of Creating an Artificial Gravity with the Help of a Short-Radius Centrifuge for Medical Support of Interplanetary Manned Missions. / J. "Aerospace and Environmental Medicine". – 2003. – V. 37, No 5. – P. 36-39.
- [5] Federal Space Program for 2016–2025, approved by Government Decree dated March 23, 2016. No 230.
- [6] R.A. Galkin, I.V. Makarov. Gravitational Therapy in Treatment of Patients with Obliterating Diseases of Lower Extremity Arteries. – Samara, 2006. – 198 p.
- [7] V.A.Akulov. Analysis and Synthesis of Medical Purpose Systems with Controlled Artificial Gravity // Diss. of Dr. of Scie, Samara, 2013. – 252 p.
- [8] V.A.Akulov. Mechatronic Systems for the Generation of Artificial Gravity of Terrestrial and Space Applications / Eds.G.P.Anshakov. – Moscow: *Mashinostroyeniye* Publishing House. 2011. – 161 c.
- [9] V. Zander, R. Anken. Short radius Centrifuge – A New Approach for Life Science Experiments Under Hyper-g Conditions for Application in Space and Beyond /Recent Patents on Space Technology, 2013, 3. P. 74–81.

Akulov V.A. – Doctor of Technical Sciences, Professor, Full Member of the International Public Association "Academy of Navigation and Motion Control", Samara State Technical University
E-mail:

Balakin V.L. - Doctor of Technical Sciences, Professor, Full Member of the International Public Association "Academy of Navigation and Motion Control", Samara National Research University named after S.P. Korolev
E-mail:

UDC 613.693 + 617.7-001.15

Modern Approaches to the Assessment of the Effect of Artificial Light Environment on the Functional Status of a Human Operator in Tests inside the Pressurized Chamber. A.E. Smoleevskiy, O.M. Manko, Yu.A. Bubeev

Abstract. The article deals with modern approaches to the assessment of the influence of artificial light environment on the functional status of a human operator and presents the results of tests of lighting systems within the pressurized chamber that simulate the artificial light environment inside working compartments of manned spacecraft.

Keywords: pressurized chamber, dynamic lighting, LED lighting, human operator, visual analyzer, functional status.

REFERENCES

- [1] Arkhangelsky D.V. Study of the Effect of Light on Visual Performance and Fatigue of a Human Taking into Account his Circadian Rhythm [Text] / D.V. Arkhangelsky, V.Yu. Snetkov // Bulletin of MPEI. – 2012. – No 6. – pp. 219–224.
- [2] Bazyleva L.V. Light-emitting Diodes as the Main Illumination: Problems and Solutions [Text] / L.V. Bazyleva, V.N. Bolekhan, V.P. Ganapolsky // 3rd Asian-Pacific Congress on Military Medicine. Proceedings of the Congress. – St. Petersburg, 2016. – pp. 7–8.
- [3] Belyaev R.I. Lighting of the Compartments of the Orbital Stations [Text] / R.I. Belyaev, A.V. Leonov // Svetotekhnika. – 2007. – № 4. – P. 41–44.
- [4] Bizyak G. Emission Spectra and Photobiological Action of LEDs [Text] / G. Bizyak, M. Klanichek-Gunde, M.B. Kobav, K. Malovr-Rebek // Svetotekhnika. – 2013. – No 2. – pp. 20–24.
- [5] Bogatova R.I. Illumination of Habitable Modules of the ISS RS [Text] / R.I. Bogatova, I.V. Kutina, A.V. Leonov, S.V. Gvozdev, R.I. Nelyaev // Space Biology and Medicine. – Vol. 1. Medical Support of the ISS's Crews. – M.: Russian Federation State Research Center – Institute of Biomedical Problems RAS, 2011. – pp. 281–298.
- [6] Bogatova R.I. The Study of the Threshold Characteristics of the Perception of Visual Information by an Operator While Regulating the Parameters of Light Environment During 105-day Isolation Experiment [Text] / R.I. Bogatova, S.M. Gvozdev, V.P. Salnitsky, I.V. Kutina, A.V. Leonov, N.D. Sadovnikova, A.E. Artyukhova, A.A. Liventsova, I.V. Tyatykh // Aerospace and Environmental Medicine. – 2011. – No 3. – pp. 30–34.
- [7] Bodrov V.A. Psychological Fundamentals of Professional Activity [Text] – M.: PER SE; Logos, 2007. – P. 855.

- [8] Bolekhan V.N. Comprehensive Study of the Effect of LED Light Sources on Human Body's Functional Status [Text] / V.N. Bolekhan, V.P. Ganapolsky, N.A. Schukina, L.V. Bazyleva // *Medicine and Healthcare: Proceedings of the 5th International Scientific Conference*. – Kazan: Publishing house "Buk", 2017. – pp. 85–88.
- [9] Voitysyak A. Biological Effect of Illumination – Traditional and LED [Text] / A. Voitysyak, Ts. Lyu // *Svetotekhnika*. – 2013. – No 2. – pp. 17–19.
- [10] Pukhov V.A. Evaluation of the Body's Functional Status of Military Specialists: Scientific and Practical Guidance [Text] / V.A. Pukhov, I.V. Ivanov, S.V. Chepur; edited by Academician I.B. Ushakov // St. Petersburg: SpecLit, 2016. – P. 312.
- [11] Ryzhov B.N. Mental Capacity Under Extreme Conditions of Professional; Activity [Text] // Thesis for the Degree of Doctor of Psychology. – M., 2001. –P. 443.
- [12] Brainard G.C. Solid-state Lighting for the International Space Station: Tests of Visual Performance and Melatonin Regulation [Text] / G.C. Brainard, W. Coyle, M. Ayers, J. Kemp, B. Warfield, J. Maida, C. Bowen, C. Bernecker, S.W. Lockley, J.P. Hanifin // *Acta Astronautica*. – 2013. – Vol. 92. – Iss. 1. – pp. 21–28.
- [13] Brainard G.C. The Development of Lighting Countermeasures for Sleep Disruption and Circadian Misalignment During Spaceflight (Review) [Text] / G.C. Brainard, L.K. Barger, R.R. Soler, J.P. Hanifin // *Current Opinion in Pulmonary Medicine*. – 2016. – Vol. 22. – Iss. 6. – pp. 535–544.
- [14] Canazei M. Artificial Skylight Effects in a Windowless Office Environment [Text] / M. Canazei, W. Pohl, H.R. Bliem, M. Martini, E.M. Weiss // *Building and Environment*. – 2017. – Vol. 124. – pp. 69–77.
- [15] Danilenko K.V. Dawn Simulation Vs. Bright Light in Seasonal Affective Disorder: Treatment Effects and Subjective Preference [Text] / K.V. Danilenko, I.A. Ivanova // *Journal of Affective Disorders*. – 2015. – Vol. 180. – pp. 87–89.
- [16] Ferlazzo F. Effects of New Light Sources on Task Switching and Mental Rotation Performance [Text] / F. Ferlazzo, L. Piccardi, C. Burattini, M. Barbalace, A.M. Giannini, F. Bisegna // *Journal of Environmental Psychology*. – 2014. – Vol. 39. – pp. 92–100.
- [17] Guo J.H. Keeping the Right Time in Space: Importance of Circadian Clock and Sleep for Physiology and Performance of Astronauts [Electronic resource] / J.H. Guo, W.M. Qu, S.G. Chen, X.P. Chen, K. Lv, Z.L. Huang, Y.L. Wu // *Military Medical Research*. – 2014. – 1:23. – p.7. Access: <http://www.mmjournal.org/content/1/1/23>.
- [18] Hoffmann G. Effects of Variable Lighting Intensities and Colour Temperatures on Sulphatoxymelatonin and Subjective Mood in an Experimental Office Workplace [Text] / G. Hoffmann, V. Gufler, A. Griesmacher, C. Bartenbach, M. Canazei, S. Staggl, W. Schobersberger // *Applied Ergonomics*. – 2008. – Vol. 39. – Iss. 6. – pp. 719–728.
- [19] Huiberts L.M. Shining Light on Memory: Effects of Bright Light on Working Memory Performance [Text] / L.M. Huiberts, K.C.H.J. Smolders, Y.A.W. de Kort // *Behavioral Brain Research*. – 2015. – Vol. 294. – pp. 234–245.
- [20] Johannes B. De-individualized Psychophysiological Strain Assessment During a Flight Simulation Test – Validation of a Space Methodology [Text] / B. Johannes, V. Salnitski, H. Soll, M. Rauch, H.J. Hoermann // *Acta Astronautica*. – 2008. – Vol. 63. – Iss. 7. – pp. 791–799.
- [21] Knez I. Effects of Colour of Light on Non-Visual Psychological Processes [Text] / I. Knez // *Journal of Environmental Psychology*. – 2001. – Vol. 21. – Iss. 2. – pp. 201–208.
- [22] Koppel T. Dynamic Lighting System for Workplaces at Northern Latitudes [Text] / T. Koppel // *Safety of Technogenic Environment*. – 2012. – No 3. – pp. 39–44.
- [23] Küller R. The Impact of Light and Colour on Psychological Mood: a Cross-cultural Study of Indoor Work Environments [Text] / R. Küller, S. Ballal, T. Laike, B. Mikellides, G. Tonello // *Ergonomics*. – 2006. – Vol. 49. – Iss. 14. – pp. 1496–1507.
- [24] Malovrh Rebec, K. White LED Compared with Other Light Sources: Age-Dependent Photobiological Effects and Parameters for Evaluation [Text] / K. Malovrh Rebec, M. Klanjsek-Gunde, G. Bizjak, M.B. Kobav // *International Journal of Occupational Safety and Ergonomics*. – 2015. – Vol. 21. – Iss. 3. – pp. 391–398.
- [25] Martensson B. Bright White Light Therapy in Depression: A Critical Review of the Evidence [Text] / B. Martensson, A. Pettersson, L. Berglund, L. Ekselius // *Journal of Affective Disorders*. – 2015. – Vol. 182. – pp. 1–7.
- [26] Santhi N. Morning Sleep Inertia in Alertness and Performance: Effect of Cognitive Domain and White Light Conditions [Electronic resource] / N. Santhi, J.A. Groeger, S.N. Archer, M. Gimenez, L.J.M. Schlangen, D.J. Dijk // *PLoS ONE*. – 2013. – Vol. 8. – Iss. 11. – e79688. – p.13. Access: [www.plosone.org/PLoS ONE 8\(11\): e79688. doi:10.1371/journal.pone.0079688](http://www.plosone.org/PLoS ONE 8(11): e79688. doi:10.1371/journal.pone.0079688).
- [27] Smolders K.C.H.J. Bright Light and Mental Fatigue: Effects on Alertness, Vitality, Performance and Physiological Arousal [Text] / K.C.H.J. Smolders, Y.A.W. de Kort // *Journal of Environmental Psychology*. – 2014. – Vol. 39. – pp. 77–91.
- [28] Smolders K.C.H.J. Investigating Daytime Effects of Correlated Colour Temperature on Experiences, Performance, and Arousal [Text] / K.C.H.J. Smolders, Y.A.W. de Kort // *Journal of Environmental Psychology*. – 2017. – Vol. 50. – pp. 80–93.
- [29] Taillard J. In-Car Nocturnal Blue Light Exposure Improves Motorway Driving: A Randomized Controlled Trial [Electronic resource] / J. Taillard, A. Capelli, P. Sagaspe, A. Anund, T. Akerstedt, P. Philip // *PLoS ONE*. – 2012. – Vol. 7. – Iss. 10. – e46750. – p 6. Access: [www.plosone.org/PLoS ONE 7\(10\): e46750. doi: 10.1371/journal.pone.004675](http://www.plosone.org/PLoS ONE 7(10): e46750. doi: 10.1371/journal.pone.004675).

- [30] Tseng P.T. Light Therapy in the Treatment of Patients With Bipolar Depression: A Meta-analytic Study [Text] / P.T. Tseng, Y.W. Chen, K.Y. Tu, W. Chung, H.Y. Wang, C.K. Wu, P.Y. Lin // European Neuropsychopharmacology. – 2016. – Vol. 26. – Iss. 6. – pp. 1037–1047.

Smoleevsky Aleksandr Yegorovich – Research Officer, Laboratory of Psychological and Psycho-Physiological Studies of Professional Activity, Virtual Reality and Computer Psychotechnologies”, Department of Psychology, Neurophysiology and Psychophysiology of Operators’ Activity, State Research Center of the Russian Federation – Institute of Biomedical Problems of the Russian Academy of Sciences

E-mail:

Manko Olga Mikhailovna – Doctor of Medicine, Leading Researcher, Head of the “Physiology and Psychophysiology of Vision” Scientific Group, Department of Psychology, Neurophysiology and Psychophysiology of Operators’ Activity, State Research Center of the Russian Federation – Institute of Biomedical Problems of the Russian Academy of Sciences

E-mail:

Bubev Yuri Arkadievich – Doctor of Medicine, Professor, Head of the Department of Psychology, Neurophysiology and Psychophysiology of Operators’ Activity, State Research Center of the Russian Federation – Institute of Biomedical Problems of the Russian Academy of Sciences

E-mail: aviamed@inbox.ru

UDC 61:629.78

Decrease of Effects of Mutagenic Factors on a Human Body Under Conditions of a Long-Term Space Flight. E.V. Popova, I.V. Kutnik, A.I. Kobatov, N.B. Verbitskaya, O.V. Dobrolezh

Abstract. The paper presents the results of experiments conducted in order to develop a simplified technology for producing fermented milk probiotic foods aboard a manned space complex (MSC). Since a variety of mutagenic factors attacks the human body during a long-term space flight, one can assume that at some moment the compensatory abilities of the human immune system will be completely exhausted.

The developed technology was shown to be a single-stage operation (“Just add water” technology) and requires neither additional equipment nor special knowledge in microbiology for its implementation. The technology was successfully tested aboard the ISS. The samples of fermented milk foods obtained by the crews of the ISS-50 and 52 have a high probiotic potential, so the said technology can be recommended for producing the treatment-prophylactic product during long-term space missions.

Keywords: mutagenes, antimutagenic activity, acidophilus probiotic product, thermostatic cultivation technology, manned spacecraft, *Lactobacillus acidophilus*.

REFERENCES

- [1] Vorobyova L.I., Alibaev S.K. Antimutagenic Properties of Bacteria (review) // Journal “Applied Biochemistry and Microbiology”, 2002. – Vol. 38. – No 2. – pp. 115–127.
- [2] Kobatov A.I., Verbitskaya N.B., Dobrolezh O.V., Petrov L.N. Probiotic “Vitaflor” as a Possible Remedy for Protecting the Cosmonauts from Negative Effects of Ionizing Radiation // Journal “Medicine of Emergency Situations”, 2007. – No 2(20). – pp. 72–79.
- [3] Kobatov A.I. Device for Production and Eating of a Fermented Milk Product in Zero Gravity Conditions. The Patent of the Russian Federation for Utility Model, No 169875. Intern. Cl. A 23C9/12, A23C9/18, 04.04.2017.
- [4] Kobatov A.I., Verbitskaya N.B., Dobrolezh O.V. Dried Prebiotic “Vitaflor-P”. The Patent of the Russian Federation No 2487547, A23C9/12, A23P1/02, A61K35/74. 20.07.2013.
- [5] Parker Yu. How to Protect Space Travelers. // Journal “V mire Nauki. Scientific American”, 2006. – No 6. – pp. 15–20.
- [6] Current Status and Prospects of Development of Means for Prevention and Treatment of Radiation Injury. / Eds. Professor V.D. Gladkikh. – Moscow: Publ. House “Kommentariy”, 2017. – p. 304.
- [7] Yarmonenko S.P., Vaison A.A. Radiobiology of Humans and Animals. – Moscow: Publ. House “Vysshaya shkola”, 2004. – p. 549.
- [8] Bodana A.R., Rao D.R. Antimutagenic Activity of Milk Fermented by *Streptococcus thermophilus* and *Lactobacillus bulgaricus* // J. Dairy Sci., 1990. – V. 73. – pp. 3379–3384.

- [9] Matar Ch., Nadathur S.S. Antimutagenic Effects of Milk Fermented by *Lactobacillus helveticus* L 89 and a Protease-Deficient Derivative // *J. Dairy Sci.*, 1997. – V. 80. – pp. 1965–1970.
- [10] Nadathur S.R., Gould S.J., Bakalinsky A.T. Antimutagenicity of Fermented Milk // *J. Dairy Sci.*, 1994. – V. 77. – pp. 3287–3295.
- [11] Popova E.V., Pushkaryova T.V. Interiorization of Cosmonauts' Professional Knowledge in the Course of Their Crew Training. // *Journal of the University of Russian Innovative Education*, 2011. – No 5. – pp. 92-95.
- [12] Kryuchkov B.I., Kuritsyn A.A., Usov V.M., Polyakov V.V., Popova E.V. Research Activity of Cosmonauts During Long-Term Space Missions // *Journal "Aerospace and Environmental Medicine"*. Moscow, 2012. No 4. pp. 22–26.
- [13] Saburov S.P., Saburov P.A., Popova E.V. Improvement of Personnel Training in the Field of Cosmonautics // *Scientific Review: Humanities*, No 4, Publishing House: "Nauka Obrazovaniya", 2017. – pp. 4–10.
- [14] Popova E.V. Formation of Skills During Professional Training of Cosmonauts for Applied Scientific Research and Experiments // *Journal "Manned Space Flights"*. 2012. – No 1(3).– pp. 114–118.
- [15] Kuritsyn A.A., Sivolap V.A., Popova E.V., Sholokhova I.A., Kutnik I.V. Use of Modern Information Technologies When Training Cosmonauts to Implement the Program of Scientific and Applied Experiments Onboard the ISS RS // *XLII S.P. Korozyov Academic Readings*. Moscow: Bauman MSTU, 2018. p. 261 (January 3 –26, 2018).
- [16] Kryuchkov B.I., Popova E.V. Analysis of Preparation and Implementation of the Scientific-Applied Research and Experiments by the Cosmonauts Aboard the ISS RS. // *K.E. Tsiolkovskiy. Issues and Prospects of Russian Science and Technology. Proceedings of the 52nd K.E. Tsiolkovskiy Academic Readings*. Kaluga, 2017. – pp. 394–395.
- [17] Kutnik I.V., Kondratenko Yu.G. Cosmonaut Training for Performing Biotechnological Experiments Aboard the ISS // *K.E. Tsiolkovskiy's Conceptions in the Innovation of Science and Technology. Proceedings of the 50th K.E. Tsiolkovskiy Academic Readings*. Kaluga, 2015.

Popova Yelena Vladimirovna – Candidate of Pedagogic Sciences, Subdivision Head, FSBO "Gagarin R&R CTC"

E-mail: E.Popova@gctc.ru

Kutnik Irina Vladimirovna – Senior Teacher, FSBO "Gagarin R&R CTC"

E-mail: I.Kutnik@gctc.ru

Kobatov A.I. – Candidate of Technical Sciences, FSUE "National Research Institute for High Purity Biologicals" of FMBA of Russia

E-mail:

Verbitskaya N.B. – Candidate of Biological Sciences, FSUE "National Research Institute for High Purity Biologicals" of FMBA of Russia

E-mail:

Dobrolezh O.V. - FSUE "National Research Institute for High Purity Biologicals" of FMBA of Russia

E-mail:

UDC 629.78.072.8

Prospects and Features of the Use of Inflatable Transformable Modules for Manned Space Complexes.

B.I. Kryuchkov, Yu.B. Sosyurka, B.V. Burdin

Abstract. The paper analyzes the achievements in the development and use of technologies of inflatable transformable modules (TMs) purposed for manned space exploration. The characteristics of experimental models of TMs obtained in the USA and Russia are given. The advantages of the TM technology as compared with existing traditional technologies are shown. The problems and features of the use of transformable modules for manned space complexes are evaluated. The main aspects of cosmonauts' activity when operating them are discussed.

Keywords: inflatable transformable modules, experimental tests of inflatable modules, inflatable module test prototype, habitation module, research module, storing module.

REFERENCES

- [1] Flexible Large Structures for Advanced Manned Complexes / Khamits I.I., Filippov I.M., Burylov L.S. and others. // Journal "Space Engineering and Technologies". – No 2(13). – 2016. – pp. 23–33.
- [2] Mark L. Holderman. NAUTILUS-X: Multi-Mission Space Exploration Vehicle, Future in Space Operations (FISO) Colloquium, 2011-01-26.
- [3] Electronic source. <https://www.popmech.ru/technologies/11402-nautilus-korabl-dlya-dalnikh-plavaniy/>
- [4] Paul Zarchan. Gossamer Spaceraft: Membrane and Inflatable Structures Technology for Space Applications. 2001. pp. 527-529.
- [5] Patent RU 2561888 C2. Russian Federation. Space Flexible Module. Khamits I.I., Burylov L.S. Chernetsova A.A.; applicant and patentee –RSC Energia; application 2013154017/11; priority: 05.12.2013. // Inventions and Utility Models. 10.09.2015. No 25.
- [6] Electronic source. <https://masterok.livejournal.com/2850281.html>
- [7] Electronic source. <http://tass.ru/kosmos/3454296>
- [8] Electronic source. <http://rusvesna.su/future/1417088195>
- [9] B.I. Kryuchkov, A.A. Kuritsyn, V.I. Yaropolov. Concepts, Directions and Prospects for the Development of Global Manned Cosmonautics. Gagarin Research&Test CTC, 2013.
- [10] Manual for Specialists on Ergonomic Support of the Processes of Design and Operation of Manned Space Complexes / V.I. Yaropolov, B.I. Kryuchkov, Yu.B. Sosurka, A.G. Larin. – Gagarin Research&Test CTC, 2017. – P. 205.
- [11] Electronic source. https://www.energia.ru/ru/news/news-2018/news_06-29_1.html
- [12] Selig, Molly M., Valle, Gerard D., James, George H., Oliveras, Ovidio M., Jones, Thomas C., Doggett, William R. Creep Burst Testing of a Woven Inflatable Module. (NASA Johnson Space Center, Houston, TX, United States). Jan 01, 2015. Document ID 20140017032/.
- [13] Patent Application Publication US 2014/0319282 A1.Space Station Configuration. Robert T. Bigelow. Assignee: Bigelow Development Aerospace / Oct.30, 2014. Int. Cl.B64G 1/12 (2006/01).
- [14] V.V Ermolov, U.U.Berd, E. Budner and others. Pneumatic Building Constructions. – Moscow: "Stroyizdat" Publ., 1983. – P. 439.
- [15] L.D. Lugantsev. Design of Shell Constructions. Part 1. – MSUEE, 2007. – 32 p.
- [16] E.P. Buslov, N.A. Gijgenko, V.V. Ustilov. Efficiency of Spacecraft's Composite Protective Shields on Impact with Hypervelocity Particles. TSNIIMash Report, electronic source: conf. nsc.ru / files / conferences / explosion /160083 / Goldenko N.A. doc, 2016.
- [17] Rudolph M., Schaefer F., Destefanis R., Farand M., Lambert M., Fragmentation of aluminium projectiles on fabrics, IAC 61 Internat.

Kryuchkov Boris Ivanovich – Doctor of Technical Sciences, Chief Researcher, FSBO "Gagarin R&T CTC"

E-mail: B.Kryuchkov@gctc.ru

Sosyurka Yuri Borisovich – Candidate of Technical Sciences, Associate Professor, Leading Researcher, FSBO "Gagarin R&T CTC"

E-mail: Yu.Sosyurka@gctc.ru

Burdin Boris Vasilievich - Candidate of Technical Sciences, Associate Professor, Subdivision Head, FSBO "Gagarin R&T CTC"

E-mail: B.Burdin@gctc.ru