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Original article

PSYCHOPHYSIOLOGICAL EXPRESS CONTROL OF PERSONS OF HAZARDOUS OCCUPATIONS OPERATING WEAPONS SYSTEMS

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Abstract. . The article presents the relevance of the development of methods for rapid control of the psychophysiological state of persons of hazardous occupations (OP), managing weapons systems, and the tasks solved with their help. The issues of improving the system of psychophysiological support of the professional activities of military operators in order to increase their professional reliability and preserve professional health are considered. The technology of vibration imaging is described, which makes it possible to assess the psychophysiological state without contact and quickly (testing time – 1 min). Examples of its practical application in training and pre-shift psychophysiological control are given.

Key words: *non-contact methods, persons of hazardous occupations, psychophysiological express control, psychophysiological state, vibration imaging technology, weapons system operators*

Conflict of interest. The authors declare no conflict of interest

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Оригинальная статья

ПСИХОФИЗИОЛОГИЧЕСКИЙ ЭКСПРЕСС-КОНТРОЛЬ ЛИЦ ОПАСНЫХ ПРОФЕССИЙ, УПРАВЛЯЮЩИХ СИСТЕМАМИ ВООРУЖЕНИЙ

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Резюме. Представлены актуальность разработки методов экспресс-контроля психофизиологического состояния лиц опасных профессий (ОП), управляющих системами вооружений, и решаемые с их помощью задачи. Рассмотрены вопросы совершенствования системы психофизиологического сопровождения профессиональной деятельности военных операторов в целях повышения их профессиональной надежности и сохранения профессионального здоровья. Описывается технология виброизображения, позволяющая бесконтактно и оперативно (время тестирования – 1 мин) оценить психофизиологическое состояние. Приводятся примеры ее практического применения при тренажерной подготовке и предсменном психофизиологическом контроле.

Ключевые слова: *бесконтактные методы, лица опасных профессий, операторы системы вооружений, психофизиологический экспресс-контроль, психофизиологическое состояние, технология виброизображения*

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Introduction

Modern intelligent ergatic systems form the basis of high-tech weapon systems. The crucial link of such systems is the human operator, on the quality, accuracy and reliability of whose activities the safety or even the very meaning of the entire system depends. In any technical system, equipment

and technological processes have anthropogenic vulnerability, and the reliability of its functioning depends on how professional, socio-biological, medico-psychophysiological characteristics of the operator meet the requirements of his professional activity, i.e. from the professional reliability of a specialist [1–4]. The low level of professional reliability of a military specialist performing a combat training mission can result in a dismiss of combat goals, in huge losses of human, material, technical and economic resources [5].

Operators who control weapons systems are classified as persons of hazardous professions, since they have such essential features as a high social significance of the profession, extremely stringent requirements for professionally important qualities, work under conditions of constant complex exposure to adverse environmental factors and activities, extraordinary dedication to their profession and a number of others [6].

Increase / maintenance of the professional reliability of persons of hazardous professions is ensured by a system of measures, which include a system of psychophysiological support [7].

Psychophysiological support is a system of measures aimed at assessing nature and level of professionally significant psychological and psychophysiological qualities that determine professional suitability and performance, at maintaining the required level of these qualities in professional activity, at correcting arising psychophysiological disorders, and at preventing mental and somatic health disorders [8].

In addition, it is a set of psychological, psychophysiological and physiological diagnostic methods and corrective measures aimed at optimizing the functional state and performance of specialists, including military personnel operating in adverse and dangerous conditions [3, 7, 9, 10].

The main directions of psychophysiological support: psychophysiological professional selection; periodic psychophysiological control; psychophysiological examination of working capacity; psychological preparation, psychological support and functional rehabilitation. The main directions can additionally include psychophysiological support of simulator training and control of the current psychophysiological state of military specialists in the process of performing professional activities.

There are specific diagnostic methods for each of these directions, including psychodiagnostic tests, psychophysiological and physiological techniques. Depending on the set of methods used, the time of the psychophysiological examination can take up to two hours. If it is acceptable at the stages of professional selection and periodic psychophysiological control, then within simulator training of operators and in the framework of their current control, it is necessary to use operational methods of express diagnostics - preferably non-contact, so as not to distract the military operator of weapons systems from performing his tasks.

The purpose of the study is to substantiate the method of psychophysiological express control of military personnel who control weapons systems..

Modern technologies for express diagnostics of psychophysiological state

A review of modern methods of express diagnostics of the psychophysiological state of a person was presented earlier and then summarized according to the criteria of contactlessness, efficiency, system-level adherence and availability for wide practical use [11, 12].

Efficiency means the ability of technical means to ensure control of the psychophysiological state of the required number of people within minimum time span. *Contactlessness* requires the absence of interaction of the subject with registration equipment and various types of sensors, i.e. the technology should be "friendly" to the user and should allow assessing the condition of a person without disturbing his/her usual activities. *System-level adherence* means that the assessment should be made not at individual, but at generalized level of psychophysiological characteristics. *Availability f*or practical use means that the measuring technology should not be a laboratory sample, but have a fairly wide application in practice.

Consideration of the phychophysiological state express control technology was carried out for two classes of devices:

- devices that record the state of blood flow in the vascular network and related phenomena - thermal imagers, Doppler, microwave and other devices;
- devices that record the physical vibrational characteristics of the body and its individual areas - eye trackers, 3D sensors, motion recorders, etc.

As a result of the comparative analysis, it was concluded that the most promising are: in the class of non-contact devices - devices that register the physical vibrational characteristics of the body and its individual parts; according to the implementation methods - the technology for evaluating the parameters of the vibraimage of human head and face [13].

The prospects of estimating the parameters of movement were mentioned by great scientists. I.M. Sechenov in 1863 in his classic work «Reflexes of the Brain» formulated the thesis that all external manifestations of brain activity can be reduced to muscle movement. Charles Darwin, in his book «On the Expression of Emotions in Man and Animals» (1872), based on the theory of evolution, argued that «reflex actions characterize the expression of emotions» [14, 15]. Outstanding biologist and psychologist of the XX century Nobel laureate Konrad Lorenz in his book «Aggression» (1966) pointed out that those who can measure the amplitude and intensity of reflex movements will be able to determine the level of aggression [16].

The principle of obtaining a vibraimage is the accumulation and analysis of interframe differences. Within this approach, the standard image (frame) is not analyzed at all, and all processing is carried out only within the interframe difference. This results in the fact that the amount of processed information is sharply reduced, and it becomes possible to process it in real time. When the interframe difference is accumulated, information about the movement of

the object is accumulated in each element of the matrix, which is focused on a certain point in space, i.e. tracking is for space, not for an object. The vibraimage reflects amplitude and frequency of vibrations of the head and parts of the human face. Each point (pixel) of the amplitude vibraimage reflects the relative movement of the image element accumulated over a certain time. Thus, for minor movements the interframe difference is proportional to the movement of the object. In contrast to the amplitude one, each point of the frequency vibraimage has a physical dimension of frequency (Hz), since it displays the frequency of signal change in each element of the image. The values of the amplitude and frequency of vibrations of the human head differ at each point in space and are displayed on the screen as a pseudo-color image [13].

Practical results of using the technology for evaluating the parameters of vibraimage in express diagnostics of psychophysiological state

The prospect of using the technology for evaluating the parameters of vibraimage for psychophysiological express control of military personnel operating weapons systems can be demonstrated by two examples: when performing simulated operator activities on a psychophysiological simulator; when carrying out psychophysiological control [17].

For the simulator training of the personnel, the psychophysiological simulator «TIBUR_TPS» (hereinafter - the Simulator) was used. It was developed by specialists of the Federal Medical Biophysical Center named after A.I. Burnazyan of FMBA of Russia (Moscow) together with the staff of the Scientific Research Institute of Molecular Biology and Biophysics (Novosibirsk) - [18]. The complex is built on the basis of interactive simulation educational games with biofeedback in a virtual environment with parallel registration of the accuracy and speed parameters of the modeled activity and physiological indicators. The simulator is designed to train specialists involved in nuclear fuel and radioactive waste management operations. The training is aimed at the development of spatio-temporal coordination, coordination-motor interaction, at increase in stress resistance, improvement of attention and memory characteristics, at formation of optimal functioning skills in extreme conditions and at prevention of psychosomatic disorders associated with long-term stress / radiophobia factors.

In the course of the simulated activity, a pneumogram, electromyogram, electrocardiogram, and galvanic skin reaction were recorded. Simultaneously, a video recording of the trainees' / test subjects' faces was carried out, followed by processing using the VibraMed program [18]. The total number of analyzed indicators is 46, the number of observations is 2837.

A high interconnection of vibraimage indices with the parameters of electrophysiological signals was established - the coefficient of canonical correlation (r) = 0.85; p = 0.001 (Table).

F1 of the trainee / test subject is the leader in the formation of the relationship with the parameters of the vibraimage: the value of the factor load is 0.98. This parameter is a spatial characteristic of movement and characterizes the degree of asymmetry of micromovements of the left and right parts of the human head, which increases with a growth of the asymmetry of micromotions. According to the author, the vibraimage technology characterizes the level of stress. An increase in this indicator is reflected, first of all, in an increase in the data of galvanic skin response (GSR) - high positive loads on the parameters of cutaneous conductivity (0.71) and its logarithm (0.60) - which are a well-known sign of an increase in human mental stress.

A high negative load (–0.60) on the standard deviation of cardiointervals shows that the level of centralization of heart rate control increases, which indicates an increase in the tension of the body's regulatory mechanisms.

The resulting relationship makes it possible to assess and to contactlessly control the current psychophysiological state of the trainee / test subject as well as the psychophysiological "price" of his/her activity, the calculation formula for which is presented in the work [18].

For the second example of the prospects of using vi-

Таблица/Table

Факторная структура канонических переменных виброизображения и электрофизиологических сигналов

Factor structure of canonical variables of vibration image and electrophysiological signals

Показатель виброизображения, усл. ед. Vibration image indicator, conventional units	Root 1
F1	**0,984**
F2	0,246
F3	-0,243
F4	-0,088
Электрофизиологический сигнал Electrophysiological signal	**Root 1**
Стандартное отклонение RR-интервалов ЭКГ, мс The standard deviation of RR-intervals of the ECG, ms	**-0,60**
Частота сердечных сокращений, уд./мин Heart rate, beats/min	0,33
Дыхательная синусовая аритмия, мс Respiratory sinus arrhythmia, ms	-0,50
Кожная проводимость, мкс Skin conductivity, mks	**0,71**
Логарифм кожной проводимости The logarithm of the skin conductivity	**0,60**
Частота спонтанных реакций кожно-гальванической реакции, 1/мин Frequency of spontaneous reactions of skin-galvanic reaction, 1/min	**0,66**
Амплитуда спонтанных реакций КГР, мкс The amplitude of spontaneous reactions of KGR, mks	0,10
Частота дыхания, дых./мин Respiratory rate, breath/min	-0,39
Длительность дыхательного цикла, с Duration of the respiratory cycle, s	0,23
Отношение длительности вдоха к длительности выдоха Ratio of the duration of inhale to the duration of exhale	-0,19
Частота моды дыхания, Гц Respiration mode frequency, Hz	-0,32
Количествр RR-интервалов на дыхательном цикле, абс. The number of RR intervals on the respiratory cycle, pcs	0,40
Значение интегральной величины электромиограммы, мкВ The value of the integral value of the electromyogram, mv	-0,11

braimage technology for psychophysiological express control of military personnel operating weapons systems, the results of psychophysiological control of persons involved in the management of spent nuclear fuel and radioactive waste are taken. Testing was carried out using the VibraStaff program [19]. The examination time is 1 min (Fig. 1-3).

To make a decision, the admission criterion (D_IND, points) was used, with the use of which one of three options for the conclusion is formed: admission to work (zone DOP1) - the psychophysiological state of the tested person is in the range of 80% confidence limit of the individual norm; conditional admission to work (zone DOP2) - the psychophysiological state is in the range between 80- and 95% confidence limits of the individual norm; non-admission to work (zone DOP3) - the psychophysiological state goes beyond the 95% confidence limits of the individual norm. The results of the assessment are clear enough. If the psychophysiological state of the second subject (see Fig. 2 - on the right) fluctuated around the average value of the individual norm (tolerance index - 56.1 points), then in the first subject (see Fig. 2 - on the left) 3 phases of changes in the psychophysiological state can be distinguished : stable phase in the period from the first to the 30th day of testing and 3 phases with a monotonous deterioration of the psychophysiological state: from 35th to 60th, from 62nd to 76th and from 85th to 105th day of testing. The data obtained make it possible for a medical worker assigned to a professional group to find out the possible reasons for such a change in order to issue recommendations for maintaining the stability of the psychophysiological state.

Conclusion

The development of new intellectual complexes of weapons, military and special equipment based on biorobotic systems requires the improvement of the system of psychophysiological support for the professional activities of military operators in order to increase their professional reliability and to maintain their professional health. At the same time, the development of methods for non-contact express diagnostics of the psychophysiological state is of great importance, the use of which allows:

Рис. 1. Процедура предсменного контроля: А – тестируемые; Б – WEB-камера, направленная на тестируемых; В – рабочее окно программы; Г – специалист, проводящий тестирование [12]
Fig. 1. Pre-shift control procedure. A – test subjects; B – WEB camera aimed at test subjects; C-working window of the program; D-specialist conducting testing

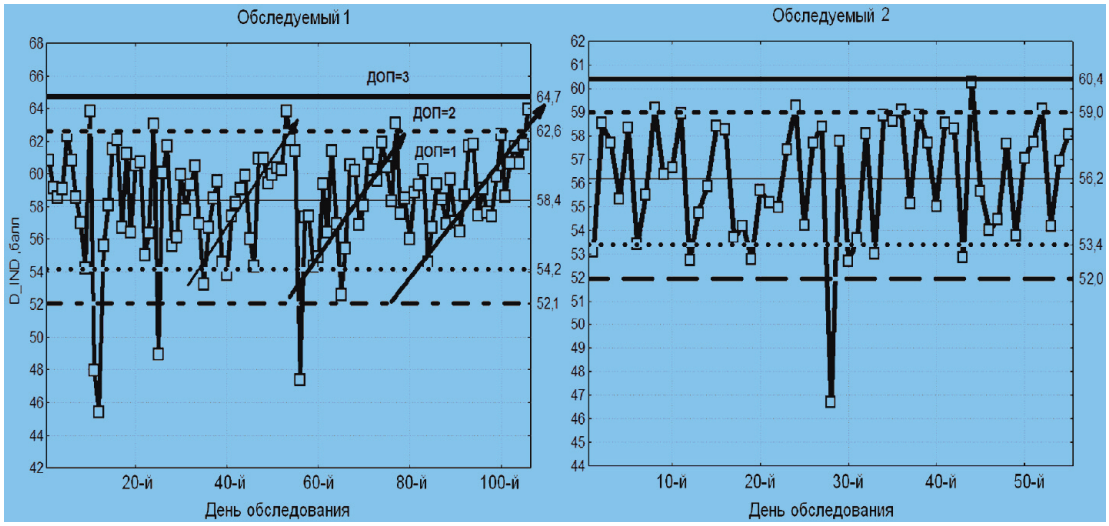

Рис. 2. Динамика предсменных психофизиологических обследований работников, получивших допуск к работе [12]
Fig. 2. Dynamics of pre-shift psychophysiological examinations of employees who have received admission to work

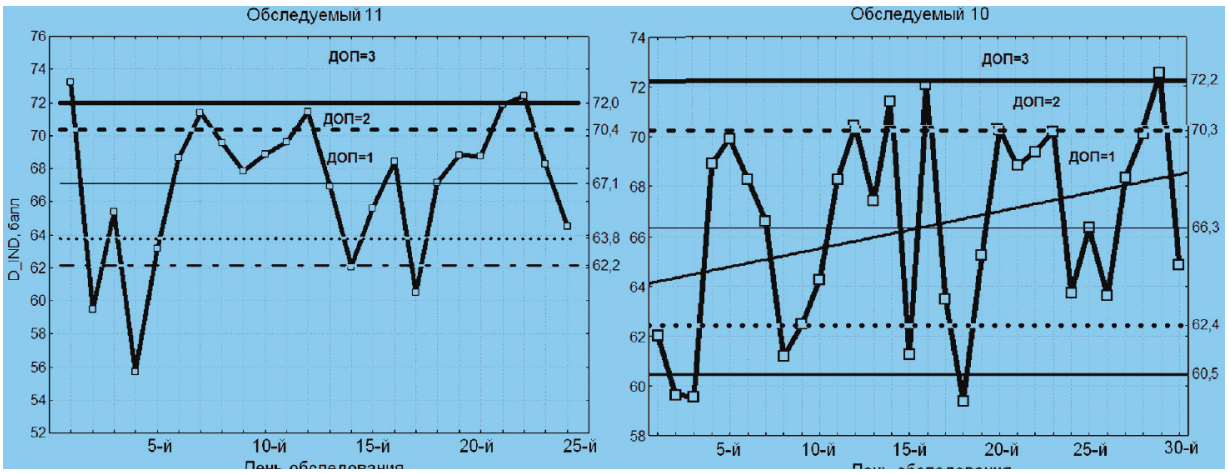

Рис. 3. Динамика предсменных психофизиологических обследований работников, имевших заключения об условном допуске (зона ДОП–2) и недопуске (зона ДОП–3) к работе [12]
Fig. 3. Dynamics of pre-shift psychophysiological examinations of employees with conclusions of conditional admission (zone DOP2) and non-admission (zone DOP3) to work

1. To optimize the training of military specialists through the operational control of the psychophysiological «price» of the performance of both individual elements of professional activity and of the entire activity as a whole.

2. To control the psychophysiological state of military specialists who take up combat duty, especially when receiving weapons.

3. If the psychophysiological state goes beyond the boundaries of an individual norm, to make timely organizational decisions on the employment of this specialist for performing the given tasks, which will reduce the risk of making mistakes in the control of weapons systems.

4. To control the psychophysiological state of military specialists during combat duty and, if it does not meet the requirements, to make timely organizational decisions about the possibility of using this specialist to fulfill the given tasks.

5. To develop work and rest regimes for military specialists within the creation and implementation of new weapons systems through operational control of the psychophysiological «price» of their activities.

A promising means of express diagnostics of the psychophysiological state is the vibraimage technology, which is operational (testing time - 1 min), contactless and low-cost when introduced into practice.

REFERENCES

1. Blaginin A.A. *Psikhofiziologicheskoe Obespechenie Nadezhnosti Professionalnoi Deyatelnosti Operatorov Slozhnykh Ergaticheskikh Sistem* = Reliability of Professional Activity of Operators of Complex Ergatic Systems. St. Petersburg, LGU imeni A.S.Pushkina Publ., 2006, 144 p. (In Russ.).

2. Bodrov V.A., Orlov V.Ya. *Psikhologiya i Nadezhnost: Chelovek v Sistemakh Upravleniya Tekhnikoy* = Psychology and Reliability: a Person in Technology Management Systems. Moscow, IP RAN Publ., 1998, 288 p. (In Russ.).

3. Ipatov P.B., Martens V.K., Sorokin A.V., Bobrov A.F., Basov V.I. *Professionalnaya Nadyezhnost Personala AES: Kontseptsiya i Tekhnologiya Kolichestvennoy Otsenki, Praktika Upravleniya* = Professional Reliability of NPP Personnel: The Concept and Technology of Quantitative Assessment, Management Practice. Saratov, SGU Publ., 2003, 232 p. (In Russ.).

4. Shcheblanov V.Y., Bobrov A.F. Reliability of Human Activity in Automated Systems and its Quantitative Assessment. *Psikhologicheskiy zhurnal.* 1990;3:60-69 (In Russ.).

5. Bulka A.P. *Sistema Organizatsii Psikhofiziologicheskikh Meropriyatiy v Vooruzhennykh Silakh Rossiyskoy Federatsii* = The System of Organization of Psychophysiological Events in the Armed Forces of the Russian Federation. Doctor's thesis in Medicine. 19.00.02. St. Petersburg Publ., 2011, 309 p. (In Russ.).

6. Fisun A.Ya., Savvin Yu.N., Zubarev A.F., Liferov R.A., Brizhan M.V., Patsenko M.B. Hazardous Occupations: Definition, Modern Approaches to Hazard Rating of Occupations. *Meditsina katastrof* = Disaster medicine. 2011;2:46–48 (In Russ.).

7. Novikov V.S. Psycho-Physiological Support of Combat Activities of Military Personnel. *Voenno-Meditsinskiy Zhurnal* = Military Medical Journal. 1996;4:37–40 (In Russ.).

8. https://determiner.ru/ URL: https://determiner.ru/termin/obespechenie-psihofiziologicheskoe.html (accessed: October 18, 2020) (In Russ.).

9. Ushakov I.B., Bogomolov A.V., Gridin L.A., Kukushkin Yu.A. *Metodologicheskie Podkhody k Diagnostike i Optimizatsii Funktsionalnogo Sostoyaniya Spetsialistov Operatorskogo Profilya* = Methodological Approaches to the Diagnosis and Optimization of the Functional State of Specialists in the Operator Profile. Moscow, Meditsina Publ., 2004. 136 p. (In Russ.).

10. Sysoev V.N., Apchel V.Ya., Kornilova A.A., Pitikin D.A., Zharken S.T. Dynamics of the Functional State of Operators During the Working Shift. *Vestnik Rossiyskoy Voenno-Meditsinskoy Akademii* = Bulletin of the Russian Military Medical Academy. 2012;4:169–172 (In Russ.).

11. Bobrov A.F., Minkin V.A., Shcheblanov V.Y., Shelkanova E.S. Contactless Diagnostics of the Psychophysiological State of the Persons Working Under Conditions of Exposure to Ionizing Radiation. Literature review. *Meditsina Truda i Promyshlennaya Ehkologiya* = Labor Medicine and Industrial Ecology. 2017;4:23–27 (In Russ.).

12. Shelkanova E.S. *Beskontaktnaya Ekspressdiagnostika Psikhofiziologicheskogo Sostoyaniya Rabotnikov Opasnykh Proizvodstv* = Rapid Noncontact Diagnostics of Psychophysiological State in Workers of Hazardous Industries. Candidate's thesis in Biology. 05.26.02. Moscow Publ., 2019, 155 p. (In Russ.).

13. Minkin V.A. *Vibroizobrazhenie* = Vibra Image. St. Petersburg, Renome Publ., 2007, 108 p. (In Russ.).

14. Sechenov I.M. *Izbrannye Proizvedeniya* = Selected works. Moscow, Uchpedgiz Publ., 1958. 413 p. (In Russ.).

15. Darvin Ch. *O Vyrazhenii Emotsiy u Cheloveka i Zhivotnykh* = On the Expression of Emotions in Humans and Animals. St. Petersburg, Piter Publ., 2001, 384 p. (In Russ.).

16. Lorents K. *Agressiya* = Agression. Moscow, Rimis Publ., 2009. 352 p. (In Russ.).

17. Shelkanova E.S. Rapid Noncontact Diagnostics of Psychophysiological State in Workers of Hazardous Industries. *Mediko-Biologicheskie i Social'no-Psikhologicheskiye Problemy Bezopasnosti v Chrezvychaynykh Situatsiyakh* = Medico-Byiological and Socially-Psychological Problems of Safety in Emergencies. 2019;2:111–120 (In Russ.).

18. Bobrov A.F., Minkin V.A., Shcheblanov V.Y., Shelkanova E.S. Non-Contact Diagnostics of Psychophysiological State in Simulator Training of People in Hazardous Occupations. *Meditsina Katastrof* = Disaster Medicine. 2016;4:55–59 (In Russ.).

19. VibraStaff Operator Psychophysiological State Monitoring Program. URL: http://psymaker.com/downloads/VIManualRuVS.pdf (accessed: October 18, 2020) (In Russ.).

СПИСОК ИСТОЧНИКОВ

1. *Благинин А.А.* Надежность профессиональной деятельности операторов сложных эргатических систем. СПб.: ЛГУ им. А.С.Пушкина, 2006. 144 с.

2. *Бодров В.А., Орлов В.Я.* Психология и надежность: человек в системах управления техникой. М.: ИП РАН, 1998. 288 с.

3. *Ипатов П.Б., Мартенс В.К., Сорокин А.В., Бобров А.Ф., Басов В.И.* Профессиональная надёжность персонала АЭС: Концепция и технология количественной оценки, практика управления. Саратов: Изд-во Сарат. ун-та, 2003. 232 с.

4. *Щебланов В.Ю., Бобров А.Ф.* Надёжность деятельности человека в автоматизированных системах и её количественная оценка // Психологический журнал. 1990. № 3. С.60-69.

5. *Булка А.П.* Система организации психофизиологических мероприятий в Вооруженных силах Российской Федерации: Дис. ... докт. мед. наук: 19.00.02. СПб., 2011. 309 с.

6. *Фисун А.Я., Саввин Ю.Н., Зубарев А.Ф., Лиферов Р.А., Брижан М.В., Паценко М.Б.* Опасные профессии: содержание термина, современные подходы к оценке степени и прогнозу опасности различных профессий // Медицина катастроф. 2011. №2. С. 46–48.

7. *Новиков В.С.* Психофизиологическое обеспечение боевой деятельности военнослужащих // Военно-медицинский журнал. 1996. №4. С.37-40.

8. https://determiner.ru/ URL: https://determiner.ru/termin/obespechenie-psihofiziologicheskoe.html (дата обращения: 18.10.2020).

9. *Ушаков И.Б., Богомолов А.В., Гридин Л.А., Кукушкин Ю.А.* Методологические подходы к диагностике и оптимизации функционального состояния специалистов операторского профиля. М.: Медицина, 2004. 136 с.

10. *Сысоев В.Н., Апчел В.Я., Корнилова А.А., Питикин Д.А., Жаркен С.Т.* Динамика функционального состояния операторов в период рабочей смены // Вестник Российской Военно-медицинской академии. 2012. №4. С. 169–172.

11. *Бобров А.Ф., Минкин В.А., Щебланов В.Ю., Щелканова Е.С.* Бесконтактная диагностика психофизиологического состояния лиц, работающих в условиях воздействия ионизирующего излучения (обзор литературы) // Медицина труда и промышленная экология. 2017. №4. С.23–27.

12. *Щелканова Е.С.* Бесконтактная экспресс-диагностика психофизиологического состояния работников опасных производств: Дис. ... канд. биол. наук: 05.26.02. М., 2019. 155 с.

13. *Минкин В.А.* Виброизображение. СПб.: Реноме, 2007. 108 с.

14. *Сеченов И.М.* Избранные произведения. М.: Учпедгиз, 1958. 413 с.

15. *Дарвин Ч.* О выражении эмоций у человека и животных. СПб.: Питер, 2001. 384 с.

16. *Лоренц К.* Агрессия. М.: Римис, 2009. 352 с.

17. Щелканова Е.С. Бесконтактная экспресс-диагностика психофизиологического состояния работников опасных производств // Мед.-биол. и соц.-психол. пробл. безопасности в чрезв. ситуациях. 2019. № 2. С. 111–120.

18. *Бобров А.Ф., Минкин В.А., Щебланов В.Ю., Щелканова Е.С.* Бесконтактная диагностика психофизиологического состояния в тренажерной подготовке лиц опасных профессий // Медицина катастроф. 2016. №4. С.55–59.

19. Программа контроля психофизиологического состояния оператора VibraStaff // http://psymker.com/ URL: http://psymaker.com/downloads/VIManualRuVS.pdf (дата обращения 18.10.2020).

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