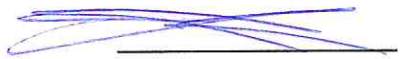
Ministry of Science and Higher Education of the Russian Federation
Federal State Autonomous Educational Institution
of Higher Education
« Peter the Great St. Petersburg Polytechnic University »

Institute of Civil Engineering

APPROVED

Director ICE

 G.L. Kozinets

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PROGRAM

of Admissions Test for Applicants to Master's Programs in the Field of Study/Educational Program

20.04.01 «Technosphere Safety»

Code and name of the area of training

Saint Petersburg
2023

ANNOTATION

The program contains a list of topics (questions) in the disciplines of the basic part of the professional cycle of the bachelor's training curriculum in the direction of **20.03.01 "Technosphere Safety"**, included in the content of tickets (test tasks) for the entrance test to the master's degree.

The entrance test is assessed on a 100-point scale and consists of:

- interdisciplinary examination in the scope of the requirements set by state educational standards of higher education for the level of bachelor's training in the direction corresponding to the master's degree, conducted face-to-face in written or oral form, or remotely (maximum score - 100);

The minimum number of points confirming successful completion of the interdisciplinary exam is 50 points (50%).

Recommended literature for preparing for exams is on the official website of the Higher School of Technosphere Safety hsts.spbstu.ru in the tab for applicants "For applicants" - "Master's degree" - "Literature for preparing for entrance examinations" (link https://hsts.spbstu.ru/literatura_dlya_podgotovki_k_vstupitelnym_ispytaniyam/)

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The program was reviewed and recommended for publication by the methodological council **ICE** (protocol dated September 26, 2023).

1. DISCIPLINES INCLUDED IN THE INTERDISCIPLINARY EXAMINATION PROGRAM

1.1. Noxology

1.2. Medical and biological foundations of safety

1.3. Technosphere safety management

1.4. Hazardous technologies and production

1.5. Reliability of technical systems and man-made risk

2. CONTENT OF ACADEMIC DISCIPLINES

2.1. Noxology

1. Topics (questions)
2. Dangers of cosmic origin.
3. Hazards of geophysical origin.
4. Geological hazards.
5. Meteorological and agrometeorological hazards.
6. Hydrological and hydrometeorological hazards.
7. Hazards caused by explosions.
8. Dangers caused by fires.
9. Hazards caused by the release of toxic substances.
10. Hazards caused by the release of radioactive substances.
11. Dangers caused by hydraulic accidents.
12. Basic concepts and definitions of noxology.
13. Principles of noxology.
14. Laws of noxology.
15. Methods of noxology.
16. Energy-entropy concept of danger.
17. Axioms of noxology.
18. Types of hazards.

19. Properties of hazards.

20. Fundamental options for the relative location of dangerous zones.

21. Vulnerability of impacted objects, resistance to external influences and conditions of vulnerability. Security. Conditional probability of defeat. Efficiency of security systems.

Literature for preparation:

1. Andreev, Andrey Viktorovich. Technosphere safety. Noxology [Electronic resource]: textbook / A. V. Andreev, A. P. Byzov, S. V. Efremov; Peter the Great St. Petersburg Polytechnic University. — Digital. text data (1 file: 1.19 MB). - St. Petersburg, 2018. - Cap. with title. Screen Access from the local network FB SPbSPU (reading, printing). — Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/s18-70.pdf>. — <URL:http://doi.org/10.18720/SPBPU/2/s18-70>.

2. Gumenyuk, Vasily Ivanovich (1950-) Noxology [Electronic resource]: textbook / V. I. Gumenyuk, O. V. Gumenyuk; Peter the Great St. Petersburg Polytechnic University Digital. text data. (1 file: 14,6 MB) St. Petersburg, 2016 (St. Petersburg, 2018) Cap. with title. Screen Access from the local network FB SPbSPU (reading, printing)Adobe Acrobat Reader 7.0 http://elib.spbstu.ru/dl/2/s18-40.pdf http://doi.org/10.18720/SPBPU/2/s18-40.

2.2. Medical and biological foundations of safety

Topics (questions):

1. What is a toxicant? Give examples of substances that are toxicants. What principles are used to classify toxicants?
2. What is a toxic process? Describe the levels at which the toxic process may occur and provide examples of the toxic process occurring at these levels.
3. List the properties of a toxicant that determine its toxicity. How do they affect the toxicity of a substance?
4. Name the subject of study of toxicometry. List and describe toxicometry parameters.
5. Define the concepts of “toxicokinetics” and “toxicodynamics”

6. As a rule, substances with the same specific clinical actions have a unidirectional effect on the human body. What groups are these substances divided into?
7. What is the difference between the zones of chronic and acute action? What is the danger of a person being in each of these zones?
8. Subject of study of toxicology. Structure of toxicology.
9. What are aerosols of predominantly fibrogenic action and what is their danger to living organisms?
10. Describe the impact of harmful factors on the organs of vision and auditory analyzer.
11. How and which body systems most often suffer from the effects of negative environmental factors?
12. List the main principles of providing assistance in case of poisoning.
13. Name harmful environmental factors. What is their danger?
14. List the general principles and mechanisms of human adaptation to the harmful effects of the environment.
15. List the physical environmental factors that have a negative impact on humans. What is the danger of exposure to each factor?
16. List the chemical environmental factors that have a negative impact on humans. What is the danger of exposure to each factor?
17. Name the ways in which harmful substances enter the human body. Which way do harmful substances most often enter the body and why? Through which route does harmful substances enter the body pose the greatest danger and why?
18. What harmful environmental factors are biological environmental factors? What is their danger?
19. What is the effect of environmental pollution on the human body and why?
20. What does industrial toxicology do.

Literature for preparation:

1. Kaverzneva, Tatyana Timofeevna. Medical and biological foundations of life safety [Electronic resource]: textbook / T.T. Kaverzneva, N.A. Chumakov, O.V. Smirnova; St. Petersburg State Polytechnic University. — Digital. text data (1 file: 3 MB). - St. Petersburg, 2013. - Cap. with title. Screen Access from the local network FB SPbSPU (reading, printing) — Text Document. — Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/3004.pdf>.

2. Chumakov N.A., Kaverzneva T.T., Faustov S.A. Toxicology (textbook) Pech. Publishing house of the Polytechnic University, 2017. St. Petersburg: 124 p.

2.3. Technosphere safety management

Topics (questions):

1. Structure of state security management in the technosphere.
2. Legislative framework for safety management in the technosphere.
3. Regulatory legal framework of state regulation in the field of protection of the population and territories in emergency situations.
4. Development of management science and practice. The concept of a control system.
5. The concept of organization, their types. The management system is a subsystem of the organization. Characteristics of the control system.
6. Management principles. Contents of management activities.
7. The concept of a decision, subjects and typology of management decisions.
8. The process of making and implementing rational decisions in management.
9. Leadership styles, concept and types. Forms of collegiality in management.
10. Fundamentals of crises and their classification, features of modern crises.
11. The meaning and features of security management in crisis situations. Situation centers and control points.
12. Risk management. Principles for making decisions about risk management.
13. Civil Defense Emergency Situations of the Russian Federation, control system, operating principles.
14. State labor protection system. System structure.
15. System for monitoring and forecasting emergency situations.

16. General procedure for management bodies to act in crisis situations.
17. Contents and stages of the management decision-making process.
18. Forecasting and planning as methods of making management decisions.
19. National crisis management center, its tasks and structure.
20. Organization of management during emergency rescue and other urgent work.

Literature for preparation:

1. Khlobystin, Nikolai Semenovich. Managing technosphere safety [Electronic resource]: textbook / N. S. Khlobystin; Peter the Great St. Petersburg Polytechnic University, Institute of Military-Technical Education and Security, Department of Management and Protection in Emergency Situations. — Digital. text data (1 file: 4.67 MB). - St. Petersburg, 2016. - Cap. with title. screen. — Access from the local network of IBC SPbPU (reading, printing). - Text file.— Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/s16-133.pdf>. — <URL:http://doi.org/10.18720/SPBPU/2/s16-133>.
2. 2. Frolov A.V., Shevchenko A.S. Technosphere safety management: textbook. – 2nd ed., revised. and additional – M.: RUSAINS, 2016. – 268 p.

Hazardous technologies and industries

Topics (questions):

1. The structure of the conceptual series in the field of man-made hazards.
2. Concepts of dangerous events.
3. Concepts associated with defeat.
4. Concepts of risk.
5. Scheme for assessing the danger of an object.
6. Brief description of damaging factors and damaging parameters.
7. General approach to determining the probability of defeat.
8. State diagram of a one-component system.
9. Selection of technology for storing and moving a substance depending on its state diagram.
10. General procedure for assessing the danger of objects containing flammable and flammable substances. Accident scenarios and shapes of affected areas.
11. Classification of hazardous chemicals.

12. Characteristics of the physicochemical properties of chemical substances.
13. Toxic properties of OHV.
14. Analysis of industrial accidents with chemical substances released.
15. Scheme for assessing the chemical situation.
16. Types of ionizing radiation.
17. Activity. Relationship between activity and dose rate.
18. Dose characteristics of ionizing radiation.
19. Human background radiation.
20. Requirements for limiting exposure.

Literature for preparation:

1. Andreev, Andrey Viktorovich. Hazardous technologies and production [Electronic resource]: textbook / A. V. Andreev, A. P. Byzov, S. V. Efremov; Peter the Great St. Petersburg Polytechnic University. — Digital. text data (1 file: 2.45 MB). - St. Petersburg, 2018. - Cap. with title. screen. — Password access from the Internet (reading, printing).— Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/s18-68.pdf>. — <URL:http://doi.org/10.18720/SPBPU/2/s18-68>.

2. Efremov, Sergey Vladimirovich. Hazardous technologies and production. Technogenic hazards [Digital resource]: textbook / S. V. Efremov; St. Petersburg State Polytechnic University. — Digital. text data (1 file: 1.70 MB). - St. Petersburg, 2008. - Cap. with title. screen. — Access from the local network of the SPbSPU FB (reading). — Text file. — Adobe Acrobat Reader 6.0. — <URL:http://elib.spbstu.ru/dl/local/2089.pdf>.

2.5. Reliability of technical systems and man-made risk

Topics (questions):

1. Determination of the risk of accidents in accordance with Rostechnadzor Order No. 144 dated April 11, 2016 “On approval of guidelines for conducting hazards and risk assessments at hazardous production facilities.”
2. Methods for qualitative and quantitative risk assessment according to Rostechnadzor Order No. 144 of April 11, 2016.
3. Determination of technical, individual, potential territorial, social and collective risk in case of man-made accidents in accordance with Rostekhnadzor Order No. 144 of April 11, 2016.

4. The purpose and objectives of hazard analysis and accident risk assessment in accordance with Rostechnadzor Order No. 144 of April 11, 2016.
5. Relationship between the probability of failure-free operation of a technical system and the risk of an accident at the facility.
6. Closed single-circuit model of the functioning of a technical system. The connection between efficiency, reliability and man-made risk in a comprehensive assessment of the safety of the functioning of a technical system.
7. Determination of the reliability of a technical system. Analytical and statistical forms of representation of the density distribution of system uptime.
8. Frequency, failure rate of technical systems, their analytical form of presentation.
9. Function of changes in the reliability and unreliability of a technical system over time.
10. Derivation of the general dependence of the reliability of technical systems on the failure rate and operating time.
11. Average time of non-failure operation of a technical system. Analytical and statistical forms of presentation.
12. Characteristics of technical systems used in reliability theory.
13. Main types of failures of elements of technical systems. Typical change in the failure rate of elements over time.
14. Laws of changes in failure rates of technical systems at various stages of the life cycle.
15. Laws of distribution of sudden failures of elements of technical systems. Properties of exponential distribution.
16. Reliability and failure rate of sequential technical systems of single action.
17. Boundaries for changing the reliability of a non-redundant technical system when taking into account only sudden failures of its devices.
18. Derivation of the dependence of the failure rate of a technical system without redundancy on the failure rates of its elements.

19. Upper and lower limits of reliability of a technical system.
20. Methodology for studying reliability indicators of a non-redundant technical system at the stage of its operation in steady state.
21. Methodology for compiling a labeled graph of states of a technical system
22. A system of differential equations that models the process of changing states of a technical system.
23. Limit probabilities of the state of a technical system, their significance in assessing the risk of accidents.
24. Various ways to increase the reliability of technical systems using redundancy. Their advantages and disadvantages.
25. Redundancy with always-on backup. Formula for assessing the reliability of a technical system with a Poisson distribution of failure rates.
26. Technical system redundancy with replacement. Formula for assessing the reliability of a technical system with a Poisson distribution of failure rates.
27. Loaded redundancy of a technical system. Methodology for assessing reliability with time-invariant intensity of the main and backup devices.
28. Technical systems with restoration. Reliability of systems with instant recovery of a failed device and with delayed recovery.
29. Reliability indicators of restored non-redundant technical systems.
30. Reliability indicators of redundant recoverable systems.
31. 31. Probability of failure-free operation of a redundant recoverable system.
32. 32. Technical system efficiency coefficient. Estimation of rational operating life of the system.
33. Determining the timing of equipment replacement for non-redundant, non-recoverable systems.
34. Logical-probabilistic method for assessing the reliability of technical systems.
35. Expressions for determining the reliability and structural significance of an element of a complex technical system.
36. Logical-graphical methods “Analysis of event trees”, “Analysis of fault trees”, used in analyzing the risk of accidents of an object.

37. Determination of the background value of risk at a hazardous production facility.
38. Practical aspects of determining the reliability of complex recoverable technical systems.

Literature for preparation:

1. Gorbacheva, Anna Alexandrovna. Reliability of technical systems and man-made risk [Electronic resource] / A. A. Gorbacheva, V. V. Yakovlev; Peter the Great St. Petersburg Polytechnic University. — Digital. text data (1 file: 2.47 MB). - St. Petersburg: Polytechnic Publishing House. University, 2016. - (Educational and methodological literature at the Polytechnic University). — Cap. with title. screen. — Access from the local network of IBC SPbPU (reading, printing). - Text file. — Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/s16-134.pdf>. — <URL:http://doi.org/10.18720/SPBPU/2/s16-134>.

2. Andreev, Andrey Viktorovich. Theoretical foundations of reliability of technical systems [Electronic resource]: textbook / A. V. Andreev, V. V. Yakovlev, T. Yu. Korotkaya; Peter the Great St. Petersburg Polytechnic University. — Digital. text data (1 file: 3.56 MB). - St. Petersburg, 2018. - Cap. with title. screen. — Free access from the Internet (reading, printing, copying).— Adobe Acrobat Reader 7.0. — <URL:http://elib.spbstu.ru/dl/2/s18-248.pdf>. — <URL:http://doi.org/10.18720/SPBPU/2/s18-248>.

3. TEST TASK EXAMPLE

Peter the Great St. Petersburg Polytechnic University

Institute of Civil Engineering

APPROVED

Program Coordinator

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«____» _____ 20___ г.

ENTRANCE TEST

in the field of study

20.04.01 «Technosphere safety»

Code and name of the area of training

Example of test tasks with answer options (maximum score – 2):

1. The microclimate of industrial premises is characterized by the following factors:
   a. temperature, atmospheric pressure, air speed b. temperature, relative humidity, atmospheric pressure
   c. temperature, lighting, presence of pollutants in the air
   d. temperature, relative humidity, air speed

2. The environment is:
   a. the surrounding space when a person performs work
   b. household items and the general environment in which a person is located
   c. the air around a person
   d. a complex of physical and biological conditions in space surrounding the organism

3. Management functions:
   a. organization, planning, coordination, control and accounting of the implementation of assigned tasks
   b. planning, coordination, motivation, control and accounting for the implementation of assigned tasks

c. organization, planning, coordination, motivation, control and accounting of the implementation of assigned tasks

d. organization, planning and accounting for the implementation of assigned tasks

4. How many categories are hazardous production facilities divided into?

   a. 4

   b. 6

   c. 5

   d. 3

5. A complex, rapidly occurring chemical oxidation process, accompanied by the release of a significant amount of heat and glow, is called:

   a. inflammation

   b. chemical reaction

   c. explosion

   d. burning

6. What does the structure of a technical system include??

   a. a technical system does not have a structure that determines its functioning

   b. a technical system consists only of interconnected devices

   c. a technical system has a strict hierarchical structure of devices and elements

   d. a technical system consists only of interconnected elements

7. Civil defense is:

   a. a system of measures to prepare for the defense and to protect the population, material and cultural assets on the territory of the Russian Federation from dangers arising during the conduct of military operations or as a result of these actions, as well as in the event of an emergency

   b. protection of the population, facilities and communications on the territory of the Russian Federation from enemy actions, sabotage or terrorist acts

   c. implementing an integrated approach to environmentally sound water management, including the protection of aquatic ecosystems and living freshwater resources

   d. maintaining the integrity of the ecosystem by conducting economic activities based on the principle that provides for the protection of aquatic

ecosystems, including living resources, and their effective protection from any type of degradation within the watershed

Example of test tasks with the ability to provide a detailed answer (maximum score – 10):

1. 1. Give reliability indicators of technical systems and give a brief description of them.

2. As a result of calculations, the following data were obtained to determine the main indicators of accident risk:

Table 1:

Conditional script code	Frequency, 1/year	Damage, million rubles.	Number of dead, people
Explosion -1	1,00E-05	120	7
Explosion -2	3,00E-04	140	5
Fire -1	2,00E-04	30	3
Fire -2	6,00E-05	50	6
Spill -1	8,00E-03	15	0
Spill -2	1,00E-04	8	0

Table 2:

Staff location	Potential Risk, 1/ year	Opening hours on site
Administrative building	2,00E-06	6
Pumping station	5,00E-05	2

Staff working hours – 8-hour working day, 40-hour working week, 28 calendar days - annual leave.

Define:

1. Collective risk
2. Individual risk
3. Expected damage

Justify the obtained results.