Formation of Scientific Foundations of Technosphere Safety Among Students of the Direction of Training "Electric Power and Electrical Engineering"

A B Bulgakov¹, S P Vashchuk², R A Panshin³

¹Department of Life Safety, Amur State University, 675027, Ignatyevskoe Shosse st., 21, Blagoveschensk, Amur Region, Russian federation
²Department of Ecology and Life Safety, Samara National Research University, 443086, Moskovskoe shosse st., 34, Samara, Russian federation
³Department of Heat Engineering and Heat Engines, Samara National Research University, 443086, Moskovskoe shosse st., 34, Samara, Russian federation

E-mail: bgd_2020@mail.ru, amurgermovvod@mail.ru, panshinroman2016@yandex.ru

Abstract. The article deals with issues related to the formation of scientific foundations of technosphere safety in the training of students and specialists in the field of electric power industry. Technosphere safety in the field of electric power engineering should be formed on the theoretical basis of the subjects of ecology and life safety.

1. Introduction
In this article, the authors draw the attention of specialists to issues related to the formation of the scientific foundations of technospheric safety among students and specialists in the field of electric power.

1.1. Relevance
An analysis of the legislative and regulatory framework, including industry-specific documents, shows that a modern specialist in the field of the electric power industry must possess not only professional, but also universal and general professional competencies. Special mention should be made of issues related to ensuring technospheric safety. Since the modern electric power industry is not only dangerous for electrical personnel, but also has a comprehensive impact on the environment and human life outside of production activities. A modern specialist in the field of electric power, in accordance with his professional duties, must be familiar with the issues of environmental, industrial (labor protection), fire and industrial safety.

2. Task statement
Development of scientific foundations of technosphere safety in students of "Electrical Power Engineering and Electrical Engineering" specialty

In our opinion, the scientific foundations of technosphere safety for specialists in the field of electric power engineering should be formed:
1) on the theoretical and practical basis of the disciplines of ecology and life safety;
2) in the performance of the graduate qualification work.

According to our belief, the discipline of ecology should form the foundation of environmental safety, and life safety - the foundation of industrial, industrial and fire safety, including specific sections related to the electric power industry.

At the present stage, in accordance with the educational standards, the ecology discipline is excluded from curricula, and life safety discipline is given no more than 144 hours. During this time, of course, it is not possible to fully study the competencies associated with technosphere safety.

The final stage of training at the university is a graduate qualification work, in which a graduate must show the application of mastered during the years of training competencies to solve specific problems of future professional activity, including in the field of technosphere safety. In accordance with modern requirements at the placement, design, construction, reconstruction, commissioning and operation of industrial facilities, including power facilities, it is necessary to consider issues related to the safety and environmental friendliness of the project. The subject of research in terms of safety and environmental friendliness, in the section "Safety and environmental friendliness of the project" are the facilities designed by the graduate in the main part of the graduate degree program. In this regard, graduates also face certain problems due to the small number of hours allocated to study the discipline of life safety.

Work on the section "Safety and environmental friendliness of the project" begins with pregraduation practice. By this stage, the student is assigned the topic of his/her thesis by the order of the rector of the university. Before sending students for pregraduation practice, they receive a consultation and an assignment for developing the section "Project safety and environmental friendliness" at the Department of Life Safety. During the pregraduation internship, the student must collect as much information as possible related to the safety and environmental friendliness of the electric power industry object designed in the thesis.

The structure of the section "Safety and environmental friendliness of the project" for the direction of preparation 03.13.02 "Power and electrical engineering" includes three subsections:
1) "Project safety";
2) "Environmental friendliness of the project";
3) "Emergencies".

The figure shows the algorithm for the development of the section "Safety and environmental friendliness of the project" in the final qualifying work.

In the subsection "Safety of the project" at the first stage, the student identifies the dangerous and (or) harmful factors of the production environment that are characteristic of the designed facility and (or) the environment in which this facility will be operated. Possible hazardous and (or) harmful production factors:
- Electricity;
- Electric arc;
- Electromagnetic fields of industrial frequency (50 Hz);
- Microclimate;
- Factors related to the light environment;
- Noise, etc.
Figure 1. Algorithm of development of the section "Safety and environmental friendliness of the project" in the graduate qualification work.

At the second stage, the designer evaluates the levels of these factors, for example, by calculation, based on data from published sources or a report on a special assessment of working conditions in an organization, and selects significant factors whose levels exceed the maximum permissible concentrations and (or) maximum permissible levels established for the working environment.

At the third stage, it proposes solutions to normalize the identified hazardous and (or) harmful production factors, i.e., those aimed at reducing the occupational risk for employees.

In the subsection "Environmental friendliness of the project" in the first stage, the student identifies the factors that are characteristic of the projected object in the main part of the EAR and have an impact on the environment, human health and livelihood outside the production environment:
- Electric field (for overhead lines (ALs) of 110 kV and above);
- Magnetic field;
- Acoustic noise (for overhead lines of 110 kV and above it is taken into account only in populated area);
- Radio and television interference;
- Dangerous and disturbing influences on the lines of communication and wire broadcasting;
- Presence of conditions causing fatalities of birds in the areas of their dispersion and on their migration routes;
- Land use restrictions;
- Disturbance of landscape aesthetics (for nature protected and recreational areas, near historical and cultural monuments);
- Pollution of the environment with transformer oils;
- Withdrawal of lands for permanent (perpetual) use;
- Withdrawal of lands for temporary use;
- Disturbance of the natural state of the soil and relief;
- Reduction of plantation areas (cutting of glades);
- Pollution of surface and ground waters (only in construction).
- Formation of ozone and nitrogen oxides (typical for high and ultra-high voltage installations);
- Environmental problems arising during operation of earthing devices (protective earthing, work earthing, lightning protection earthing).

At the second stage he assesses the levels of these factors, e.g. by calculation method and selects significant factors the levels of which exceed MPC or MPL for the environment and settlements.

At the third stage, it proposes solutions to normalize the identified negative impacts on the environment.

In the "Emergencies" subsection, the first step is for the student to identify emergencies that are likely to occur in the project. In the second stage, he makes an assessment of the risk of such emergencies, and in the third stage, he proposes solutions that will reduce the risk of these emergencies. As emergencies in the section can be considered the events associated with the disruption of electricity supply to the economy and settlements, equipment failure at the designed facility, fire, etc.

Theoretical aspects of the issues considered in the section "Safety and environmental friendliness of the project" and a number of methods for calculating the levels of significant factors and measures are given in [1-6].

Recommended list of documents for the development of the section "Safety and environmental friendliness of the project":
- GOST 12.0.003-2015. SSBT "Hazardous and harmful production factors. Classification";
- Order of the Ministry of Labor of the Russian Federation of January 24, 2014 № 33н (as amended on 14.11.2016) "On approval of the methodology of a special assessment of working conditions, the classifier of harmful and (or) hazardous production factors, the report form on the special assessment of working conditions and instructions for its completion";
- Order of the Ministry of Labor and Social Protection of the Russian Federation of December 15, 2020, No. 903n "On Approval of the Rules for Labor Safety in the Operation of Electrical Installations";
- Order of the Ministry of Energy of the Russian Federation of June 19, 2003 № 229 (ed. from 09.01.2019) "On approval of the Rules of technical operation of electrical stations and networks of the Russian Federation";
- Rules for the arrangement of electrical installations;
- STO 56947007-29.240.55.192-2014 Norms of technological design of overhead power lines of 35-750 kV;
- STO 56947007-29.240.037-2010 Environmental safety of electric grid facilities. Design requirements;
- STO 56947007-29.240.038-2010 Environmental Safety of Power Grid Facilities. Requirements for construction;
- STO 56947007-29.240.039-2010 Environmental safety of electric grid facilities. Requirements for maintenance and repair;
- STO 56947007-29.240.040-2010 Environmental safety of electric grid facilities. Requirements for reconstruction and liquidation;
- STO 56947007-29.240.10.248-2017 Norms of technological design of AC substations with high voltage 35-750 kV;
- RF Government Resolution No. 486 of August 11, 2003 "On Approval of the Rules for Determining the Sizes of Land Plots for Locating Overhead Power Lines and Communication Line Supports Serving Electricity Networks";
- Departmental Construction Standards #14278 tm-t1 "Land Allocation Norms for 0.38 - 750 kV Electric Networks". (Approved by the Department of Electric Power Industry of the Ministry of Fuel and Energy of the Russian Federation on May 20, 1994);
- GOST 12.2.024-87 "System of standards of safety at work. Noise. Power oil transformers. Norms and Methods of Control;
- Decree of the Chief State Sanitary Doctor of the Russian Federation of January 28, 2021 № 2 On Approval of Sanitary Regulations and Norms SanPiN 1.2.3685-21 "Hygienic Standards and Requirements to Ensuring Safety and (or) Harmlessness of Living Environment Factors for Human;
- RD 153-34.3-02.205-00 "Methodological instructions on regulating pollutant discharges with wastewater of electric grid enterprises";
- RD 153-34.3-02.206-00 "Recommendations on development of draft standards of generation and limits of waste disposal for power grid enterprises
- Order of the Ministry of Energy of Russia from 23.07.2012 № 340 (ed. from 20.12.2017) "On approval of the list of information provided by the subjects of electric power industry, forms and procedure for its provision";
- Order of the Ministry of Energy of the Russian Federation No. 1110 of November 23, 2017 "On ensuring the reliable operation of electric power industry facilities during weekends and non-working holidays in 2018";
- RD 153-34.0-03.301-00 "Fire Safety Rules for Power Facilities".

The volume of the section "Safety and environmental friendliness of the project" is (10-15) % of the undergraduate paper, not including applications. In one of the subsections of the section "Safety and environmental friendliness of the project" must be performed calculation. The section is submitted for review to the teacher of the Department of Life Safety in a printed, edited form with an attachment of a bibliographic list of the literature used to write the section. On the title page indicate the full name, group number and theme of the thesis.

After reviewing the section, the instructor-advisor signs the title page to the bachelor's work, if the section corresponds to the task and the solutions to ensure the safety and environmental friendliness of the project are taken in it, or it is returned for revision.

Analysis of the materials showed that about 25% of students have problems with the development of the section "Safety and environmental friendliness of the project". According to the students, this is due to the large amount of material that they have to study within the discipline "Life Safety" for a very small number of hours and the absence of the discipline "Ecology".

3. Practical significance
The implementation of the proposed recommendations will fully ensure the training of specialists in the field of electric power industry with the competence of technosphere safety.

4. Conclusion
1. To form scientific foundations of technosphere safety when training students, masters and specialists in the field of electric power industry in accordance with professional standards, additional competencies should be formed on the theoretical basis of disciplines of ecology and life safety in the following areas: environmental safety; industrial safety (labor protection); fire safety, industrial safety.
2. To form practical skills in formation of competences listed in clause 1, it is necessary to introduce on disciplines of ecology and life safety, laboratory practicals with elements of scientific research.
3. The volume of teaching hours on disciplines of ecology and life safety must be at least 144 and 216 hours. On the discipline of life safety, it is recommended to introduce coursework with elements of scientific research.
5. References

[1] Bulgakov A B 2014 Safety of vital functions The module is «Theoretical bases of safety of vital functions» Train aid for students special 140400.62 «Electroenergy and electrical engineering» (Blagoveshchensk: Publishing house AmSU) 81 http://irbis.amursu.ru/DigitalLibrary/AmurSU_Edition/6986.pdf.

[2] Safety of vital functions: method. decree to employments for students on special: 140400.62 «Electroenergy and electrical engineering» (Blagoveshchensk: Publishing house AmSU) 100 http://irbis.amursu.ru/DigitalLibrary/AmurSU_Edition/6979.pdf

[3] Bulgakov A B 2017 Safety of labour: collection of teaching methods materials for direction of preparation 20.03.01 «Safety is in a technosphere» of AmSU (Blagoveshchensk: Publishing house AmSU) 285 http://irbis.amursu.ru/DigitalLibrary/AmurSU_Edition/9045.pdf

[4] Bulgakov A B, Averyanov V N, Gritsenko M V 2017 Safety of vital functions: collection of teaching methods. materials for direction of preparation 01.03.02, 03.03.02, 09.03.01, 09.03.02, 09.03.03, 13.03.01, 13.03.02, 15.03.04, 18.03.01, 20.03.01, 24.03.01. 29.03.02, 29.03.05, 37.03.01, 38.03.01, 38.03.02,38.03.04, 38.03.05, 38.03.06, 38.03.07, 39.03.01, 39.03.02, 40.03.01, 41.03.01, 42.03.01, 42.03.02, 43.03.01, 43.03.02, 43.03.03, 44.03.02, 44.03.05, 45.03.01, 45.03.02, 45.03.03, 47.03.03, 54.03.01, 21.05.02, 21.05.04, 24.05.01, 37.05.01, 38.05.01, 38.05.02, 45.05.01, 54.05.01 (Blagoveshchensk: Publishing house AmSU) 176 http://irbis.amursu.ru/DigitalLibrary/AmurSU_Edition/9036.pdf

[5] Bulgakov A B 2019 Section "Safety and Environmental Design" in the graduate qualification work of 13.03.02 "Electric Power Engineering and Electrical Engineering" Power Engineering: Management, Quality and Efficiency of Energy Resources: Proceedings of the IX International Scientific and Technical Conference (Blagoveshchensk: Amur State University) pp 487-491

[6] Bulgakov A B, Vashchuk S P 2021 Normative legal acts on labor protection: tutorial, Amur State University, Department of Life Safety (Blagoveshchensk: Publishing house of Amur State University) http://irbis.amursu.ru/DigitalLibrary/AmurSU_Edition/11644.pdf