TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

APPROVED BY

Director of Nuclear Science & Engineering School
_____ / Oleg Yu. Dolmatov
"25" 06 2020

Course Name: Physical Protection of Nuclear Facilities, Radiation Sources, Storage Facilities, Nuclear Materials and Radioactive Substances

Field of Study: Nuclear Science and Technology

Programme name: Nuclear Science and Technology

Specialization: Nuclear Safety, Security and Non-Proliferation of Nuclear Materials

Level of Study: Master Degree Programme

Year of admission: 2020

Semester, year: semester 3, year 2

ECTS: 5

Total Hours: 180

Contact Hours: 64

- **Lectures:** 16
- **Practical experience:** 32
- **Labs:** 16

Self-study: 116

Assessment: Exam, Graded credit-test

Division: Nuclear Fuel Cycle

Director of Programme _____ / Vera V. Verkhoturova

Instructor _____ / Boris P. Stepanov

Course name: Physical Protection of Nuclear Facilities, Radiation Sources, Storage Facilities, Nuclear Materials and Radioactive Substances

Course Overview

Course Objectives	The objective of the training course "Physical Protection of Nuclear Facilities, Radiation Sources, Storage Facilities, Nuclear Materials and Radioactive Substances" is to develop students' knowledge of and skills in establishment, design, creation of efficient physical protection systems at nuclear and radiation facilities and organization of activities related to nuclear power facilities vulnerability analysis.
Learning Outcomes	**Upon completion of the course, a graduate will obtain the knowledge of:** – stages of the project life-cycle; – stages of the project development and implementation; – methods of the project development and management; – fundamentals of report structuring and presentation preparation in a foreign language (English) accepted in the international community; – objectives and tasks of scientific research related to the professional fields, basic principles and methods of its organization; – methods and ways of implementing the analysis of the process activities as a management object in the field of nuclear energy use; – requirements to assurance of nuclear and radiation safety at the operations connected with nuclear and radioactive materials handling, operation of nuclear facilities and radiation sources at nuclear power facilities; – methods and principles of approaches to the solution of problems related to safe management of nuclear and radioactive materials at nuclear and radiation facilities; – requirements to assurance of physical protection and security at the operations connected with nuclear and radioactive materials handling, operation of nuclear facilities and radiation sources; – types of threats for nuclear and radiation facilities, devices and methods of furnishing the secure area boundaries within the physical protection system, adversaries' tactics; – regulatory framework in the field of nuclear energy use, features of application of rules and regulations related to the nuclear materials and nuclear facilities physical protection assurance at nuclear and radiation facilities, regulatory requirements to the organization of physical protection systems; – criteria for selection of capabilities for the performance of professional activity. **Upon completion of the course, graduates are expected to develop the following skills:** – to develop a project based upon the analysis of its implementation alternative options, determine the milestones and priorities in the activities; – to explain the objectives and formulate the tasks related to the project preparation and implementation; – to manage the project at all stages of its life-cycle; – to compile and present technical and scientific documentation used in the

	professional field in the form of presentation; – to prepare a general plan of actions on the specified issue, propose research methods and techniques of results processing; – to use regulatory legal documents and technical documentation in the field of professional activity, design security systems, analyze technical solutions for improvement of nuclear and radioactive materials physical protection organizational structure at nuclear power facilities; – to create the adversary model, describe the scenarios of unauthorized actions and evaluate the consequences of radiation effect from the actions committed by adversaries with regard to nuclear and radioactive materials; – to distinguish basic components of the set task for the assurance and organization of the physical protection of nuclear facilities, radiation sources, storage facilities, nuclear materials and radioactive substances; – to apply up-to-date requirements and techniques for performing the vulnerability analysis of nuclear and radiation facilities, organize operations related to the physical protection system design and functioning; – to apply safety requirements and present established reports within the development of systems, facilities, and devices. **Upon completion of the course, graduates should acquire the practical experience in:** – applying methods of the project development and management; – evaluating the project efficiency and resource requirements; – mastering communication skills in a foreign (English) language within the field of professional training with the use of supplementary tools (table, graphs, diagrams, etc.); – applying the main methods of project development and physical protection systems design at nuclear power facilities; – organizing and establishing the physical protection system at nuclear and radiation facilities; – conducting the activities related to the organization of the physical protection of nuclear facilities, radiation sources, storage sites, nuclear and radioactive materials; – simulating the operation of physical protection system elements and the interaction of its subsystems when countering internal and external threats; – conducting the preliminary feasibility study of design calculations based upon the current rules and regulations in the field of nuclear energy use.
Course Outline	The training course is delivered through the following teaching modes: – 8 lectures; – 3 labs; – 16 practical experiences. The course consists of 3 sections, which are given below. **Section 1. Assurance of nuclear materials and radioactive substances physical protection.** **Section 2. Physical protection system design and establishment at nuclear facilities.** **Section 3. Construction of a complex of engineering and technical means of physical protection at nuclear and radiation facilities.** Each section includes several lectures, laboratory and practical experiences.

	The training course finishes with an exam which is scored with the maximum of 20 points. In the course of study, students are to defend three lab-based reports which are scored with the maximum of 10 points each, perform a review which is scored with the maximum of 15 points and a group assignment which is scored with the maximum of 20 points. Besides, the course implies conducting a test which is scored with the maximum of 15 points.
Course Structure	The content of the course covers 3 topics. Each topic is studied through lectures, labs, and practical experiences, as well as self-study. **Section 1. Assurance of nuclear materials and radioactive substances physical protection.** Organization of the physical protection (PP) of nuclear facilities, radiation sources, storage sites, nuclear materials and radioactive substances. Purposes, performed functions, characteristics. Purpose, structure, and operation principles of the state physical protection system, state control and accounting system of nuclear materials and radioactive substances. Procedures and means of PP operation. **Topics of lectures:** 1. Organization of the PP of nuclear facilities, radiation sources, storage sites, nuclear materials and radioactive substances. 2. Assurance of safe handling of nuclear and radioactive materials. **Topics of practical experience tutorials:** 1. Organization of physical protection system at nuclear and radiation facilities. 2. Administrative procedures for access control organization. 3. Categorization of physical protection items. 4. Selection of the PPS structure at the NF. 5. PPS establishment and operation. **Topics of laboratory experiences:** 1. Operation of the radiation monitor combined with a metal detector. **Section 2. Physical protection system design and establishment at nuclear facilities.** Organizational structure of physical protection system. Main requirements specified to the organization and construction of PPS at the NF. PPS organization at a radiation facility. PPS design stages. Operation of a complex of engineering and technical means of physical protection at nuclear and radiation facilities. Equipment of secure area boundaries at NF. Formation of requirements to the PPS organization at a radiation facility. **Topics of lectures:** 3. Basics of the PPS design at NF. 4. Construction and operation of physical protection system elements at a radiation facility. 5. Organization of authorized access at nuclear and radiation facilities. **Topics of practical experience tutorials:** 6. Implementation of access control at nuclear and radiation facilities. 7. Construction of the complex of engineering and technical means of physical protection. 8. Equipment of access control points. 9. Organization and equipment of human, transport and railway checkpoints at NF.

	10. Access control system. 11. CCTV means. **Topics of laboratory experiences:** 2. Organization of "Biosmart" biometric identification means operation for assurance of access control. **Section 3. Construction of a complex of engineering and technical means of physical protection at nuclear and radiation facilities.** Establishment and equipment of the PPS control center. Access control at nuclear and radiation facilities. Data collection and processing tools. Methods of integrating the data collection tools and PPS autonomous subsystems into the unified system. Implementation of requirements to the PPS elements at a radiation facility. **Topics of lectures:** 6. Organization of technical subsystems management in the PPS at nuclear facilities. 7. Selection of PPS technical means at RF. 8. Operation of physical protection system elements in case of alarm signals. **Topics of practical experience tutorials:** 12. Conducting a vulnerability analysis of nuclear and radiation facilities. 13. Structure formation of physical protection system. 14. Selection of elements and devices of a complex of engineering and technical means of physical protection. 15. Management of the elements within the complex of engineering and technical means of physical protection. 16. Selection of the design for furnishing the secure area boundaries. **Topics of laboratory experiences:** 3. Organization of the PPS control center operation. **Topics of the course projects:** 1. Assurance of radioactive materials safe handling at a radiological center. 2. Assurance of nuclear materials safe handling at the nuclear facility with a research reactor. 3. Assurance of irradiated nuclear fuel safe storage at the storage facility. 4. Establishment of the physical protection system at a nuclear power plant with a light-water reactor. 5. Assurance of nuclear material safe handling at a nuclear power plant with a fast-neutron reactor. 6. Establishment of the physical protection system for a healthcare center. 7. Establishment of physical protection at a radiation facility with the operation of radiation sources. The training course provides for the graduates' self-study of the following types and forms: – Study of lecture materials, search and review of literature and electronic information resources on the individually specified course topic; – Study of topics submitted for independent examination; – Information research, analysis, structuring, and presentation of information and data obtained; – Preparation for laboratory experiences and seminars; – Performance of the course work; – Analysis of scientific publications on the topic predetermined by the

	instructor; – Preparation for assessment activities.
Facilities and Equipment	1. Classrooms with multimedia equipment for practical experiences: Tomsk, Lenin ave. 2, build. 10, room 312, 313; 2. Equipment for practical experiences: – Complex of security and CCTV systems; – Training system of radio-ray security alarm system "Astra"; – Canon PowerShot S5 IS camera; – Radiation monitoring systems for nuclear materials bringing control; – Automated workplace; – Analytical complex of security systems, identification tools, detection tools and CCTV equipment; – Laminating machine for ID cards production Fellowes SPLA4; – Network IP-camera Cisco CIVS-IPC-2520V; – Printing device STYLUS Photo R800; – Colour camera SAMSUNG SVD-4400P; – Special cutting machine Warrior 21173C; – Training system of the physical protection system security assurance; – 15 computers; – 3 printers.
Grading Policy	In accordance with TPU rating system we use: – Current assessment which is performed on a regular basis during the semester by scoring the quality of mastering of theoretical material and the results of practical activities (performance tests, perform tasks, problem solving). Max score for current assessment is 80 points, min – 44 points. – Course final assessment (exam/ credit test) is performed at the end of the semester. Max score for course final assessment is 20 points, min – 11 points. The final rating is determined by summing the points of the current assessment during the semester and protection of the course project at the end of the semester. Maximum overall rating corresponds to 100 points, min pass score is 55.
Course Policy	Attendance is strictly controlled. All classes are obligatory for attendance.
Teaching Aids and Resources	**Compulsory reading:** 1. Cyber and Chemical, Biological, Radiological, Nuclear, Explosives Challenges. Threats and Counter Efforts / by editors M. Martellini, A. Malizia, — Cham: Springer, 2017. — X, 407 с. — Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-3-319-62108-1 (дата обращения: 10.04.2020). — Режим доступа : по подписке. 2. Nuclear Power Plants: Innovative Technologies for Instrumentation and Control Systems. International Symposium on Software Reliability, Industrial Safety, Cyber Security and Physical Protection of Nuclear Power Plant / by editor Y Xu. — Singapore : Springer, 2017. — IX, 224 с. — Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-981-10-3361-2 (дата обращения: 10.04.2020). — Режим доступа : по подписке.

3. Safety and Risk Modeling and Its Applications / by editor H. Pham. – London : Springer-Verlag Ltd., 2011. – XIV, 429 p. – Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007/978-0-85729-470-8 (дата обращения: 20.09.2020). – Режим доступа : по подписке.
4. Morse, E. C. Analytical Methods for Nonproliferation / E. C. Morse. — Cham : Springer International Publishing, 2016. — XIII, 250 p. — Текст: электронный // SpringerLink. – URL: https://link.springer.com/book/10.1007%2F978-3-319-29731-6 (дата обращения: 20.09.2020). – Режим доступа : по подписке.

Additional reading:

1. Verma, A. K. Risk Management of Non-Renewable Energy Systems / A. K. Verma, S. Ajit, H. P. Muruva. — Cham: Springer, 2015. — XVII, 422 p. — Текст : электронный // SpringerLink. — URL: https://link.springer.com/book/10.1007/978-3-319-16062-7 (дата обращения: 10.04.2020). — Режим доступа : по подписке.

Internet resources (including LMS MOODLE and other teaching aids and library resources):

1. Preventive and Protective Measures against Insider Threats / IAEA Nuclear Security Series No. 8-G (Rev. 1). — Vienna : IAEA, 2020. — 52 c. — ISBN 978–92–0–103419–9 — Текст : электронный // INTERNATIONAL ATOMIC ENERGY AGENCY. — URL: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1858_web.pdf (дата обращения: 10.04.2020).
2. Planning and Organizing Nuclear Security Systems and Measures for Nuclear and Other Radioactive Material out of Regulatory Control / IAEA Nuclear Security Series No. 34-T. — Vienna : IAEA, 2019. — 52 c. — ISBN 978–92–0–100119–1 — Текст : электронный // INTERNATIONAL ATOMIC ENERGY AGENCY. — URL: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1858_web.pdf (дата обращения: 10.04.2020).
3. Security of Nuclear Material in Transport / IAEA Nuclear Security Series No. 26-G. — Vienna : IAEA, 2015. — 120 c. — ISBN 978–92–0–102015–4 — Текст : электронный // INTERNATIONAL ATOMIC ENERGY AGENCY. — URL: https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1686_web.pdf (дата обращения: 10.04.2020).
4. Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5) / IAEA Nuclear Security Series No. 27-G. — Vienna: IAEA, 2018. — 136 c. — ISBN 978–92–0–111516–4 — Текст : электронный // INTERNATIONAL ATOMIC ENERGY AGENCY. — URL: https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1760_web.pdf (дата обращения: 10.04.2020).
5. Security of Radioactive Material in Use and Storage and of Associated Facilities / IAEA Nuclear Security Series No. 11-G (Rev.1). — Vienna : IAEA, 2019. — 120 c. — ISBN 978–92–0–110018–4 — Текст : электронный // INTERNATIONAL ATOMIC ENERGY AGENCY. — URL: https://www-

	pub.iaea.org/MTCD/Publications/PDF/PUB1840_web.pdf (дата обращения: 10.04.2020).
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