TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное
образовательное учреждение высшего образования
«Национальный исследовательский Томский политехнический университет» (ТПУ)

Field of training (specialty): 14.06.01 Nuclear, Thermal and Renewable Energy and Related Technologies, 05.14.03 Nuclear Power Plants: Design, Operation and Decommissioning.
School: Nuclear Science & Engineering
Division: Nuclear Fuel Cycle

Scientific qualification work

Topic
The development of analytical model of security system functioning factored in elements of external influence

UDC 621.039.58-026.91-028.45-047.58

PhD student

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Tomsk – 2022

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**«НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ»**

Направление подготовки/профиль: 14.06.01 Ядерная, тепловая и возобновляемая энергетика и сопутствующие технологии, 05.14.03 Ядерные энергетические установки, включая проектирование, эксплуатацию и вывод из эксплуатации
Школа: Инженерная школа ядерных технологий
Отделение: Отделение ядерно-топливного цикла

Научно-квалификационная работа

Тема научно-квалификационной работы
Разработка аналитической модели функционирования системы безопасности, учитывающей элементы внешнего воздействия

УДК 621.039.58-026.91-028.45-047.58

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Томск – 2022 г.

Annotation

Nuclear technologies currently in use are characterized by systems with features that ensure the security of radiation materials at facilities. Radiation security recommendations have been developed by international organizations and expects but these documents do not take into account functional features of security systems in the State's territory. Models have been developed and used in nuclear facilities but a little has been done in terms of radiological facilities thus, there is a need to develop effective security system models for radiological facilities. Regulation requirements cover an incomplete list of possible scenarios for the realization of project threats. Possible solution to the challenges in assessing the level of the nuclear security at a nuclear facility is by modeling of security system processes. The work is devoted to the development and creation of an analytical investigative model to effectively secure radiological facilities considering the impact external influence during an event of unauthorized actions. Assessment of external adversaries that might attack a radiological facility was made in order aid in designing effective physical nuclear security for radiological facilities. In the construction of the analytical model, the recommendations of international organizations and existing experience of physical nuclear systems procedures were taken into account to develop adversary sequence diagram. The modeling process combined adversary sequences diagrams to visualize the possible paths an external adversary may employ to attack a radiological facility, estimate of adversary sequence interruption model to determine the overall probability of interruption value of a physical nuclear security system. The model also analyzes risk associated to the radiological facility considering various probability of attack. Improvement strategies was developed and applied to the analytical model to obtain effective physical security regime for the radiological facility as result. The analytical model demonstrates that the chance of interrupting an external adversary has significantly improved which implies that an attacker is more likely to be detected and interrupted as a result of the improvement strategies. The reduction of the risk value

associated with the hypothetical radiological facility indicates that the reliability of the established security system is enhanced.

This analytical model demonstrates an effective physical nuclear security regime for radiological facilities and when appropriately applied to a radioactive facility; this study can assist in making critical decisions about security.