Министерство науки и высшего образования Российской Федерации
федеральное государственное автономное образовательное учреждение
высшего образования

**«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
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TOMSK POLYTECHNIC UNIVERSITY ТОМСКИЙ ПОЛИТЕХНИЧЕСКИЙ УНИВЕРСИТЕТ

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Scientific qualification work

Topic
Modeling of the interaction processes in the security system

UDC: 621.039.58-047.58

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Annotation

The research work is devoted to the modeling of the interaction processes in the security system. With existing approaches, an assessment of the effectiveness of the respective security system presents difficulties related to the analyses of multiple tactics adapted by the various known adversaries. A thorough study of the formation of the main approaches is therefore carried out and related to the features of the functioning security systems associated with nuclear technological applications. The primary purpose of investigating the modeling methodologies is to ascertain that the physical nuclear security system of the associated nuclear facility provides a high overall system effectiveness against the design-basis threat (DBT). The physical protection system at the nuclear facility site integrates people, procedures, and equipment for the protection of assets or facilities against theft, nuclear sabotage, theft of special nuclear material, or other malevolent human attacks which could occur at associated facilities and through its activities. The modeling process involves the mathematical predictive representation of the probability efficiency of mechanical barrier systems, electronic security systems, and physical and schedule protection elements for the interruption of adversaries together with the transition matrix operation elements consisting of the multiple path or adversary sequence in the security system. The modeling concept operates by the multiplication of the probability efficiency values of the mechanical barrier systems, electronic security systems, and physical and schedule protection elements for the interruption of adversaries as an initial state input vector from the EASI model, which is combined with the transition matrix of the adversary sequence relevant to the associated security system, in the Markov modeling methodology. The main elements of these interaction processes in real time security systems include: organizational measures, a detection program for security, alarm system response, radio communications, tactical communications, access control systems and management systems, and deterent measures during emergency response. The research analyzes a hypothetical nuclear facility using the Estimate of Adversary Sequence Interruption (EASI) model and Markov process. In this research work, the Markov process evaluates the hypothetical facility's Physical Protection System (PPS) to assess possible entrances leading into the facility and the interaction protection elements established. It performs repetitive runs on the physical security system, which also represents the multi-level adversary path to evaluate the interruption processes. The evaluation informs the research work of the updated protection elements which are inherent in the security system that could likely be maintained to improve the physical nuclear security system design to the extent that it reaches the desired response margin or enrich the overall system effectiveness. Each level of the interaction process may grant insights to support the facts as to which physical nuclear security elements are the most efficient and effective. In achieving this, the probability of adversary interruption (PI) as the adversary seeks to enter the hypothetical nuclear facility and get to the target is calculated. The output results of the Markov process are represented by the multiple path significance of the threats, vulnerabilities and consequences as a result of the interacting mechanical, electronic and physical

schedule protection systems. An evaluation of the created modeling methodological approach and the analysis of the results obtained has showed that the appropriate balance of the hypothetical facility resources may cause a significant change in the facility's probability of interrupting an adversary. This multi-level modeling methodology, when adopted as a tool, can be used in predicting the resultant of various case scenarios in the physical security system to a higher level of precision and accuracy. These redesigned updates are meant to aid administrators of various critical infrastructures informed, to ensure effective security and in order to be ahead of all kinds of adversaries.