Advanced Nuclear Security Program at The Joint Institute for Power and Nuclear Research - Sosny

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Abstract. The Republic of Belarus is a participant in global efforts for nuclear non-proliferation, ensuring the preservation of nuclear materials and countering nuclear terrorism. In accordance with the Decree of the President of the Republic of Belarus No. 124 dated March 29, 2011, the Joint Institute for Power and Nuclear Research – Sosny of National Academy of Science of Belarus is the operator (operating organization) of a number of critical and subcritical nuclear facilities, radiation installations and fresh nuclear fuel storage, containing highly enriched uranium fuel. A nuclear security culture is an important necessary constituent of the nuclear and radiation security. The authors of this paper will report on the approach the Institute is taking in regard to advancing nuclear security program, what are the Institute’s goals and objectives, and what steps are being taken to support effective the physical protection system at the Scientific Institution “JIPNR - Sosny” and another operating organization in the Republic of Belarus. The range of measures aimed at reducing the likelihood of internal violators activity, early detection of potential internal violators and preventing from causing harm are presented.

1. Introduction
The first Belarusian nuclear power plant (NPP) is being commissioned in the Republic of Belarus. For the country most affected by the Chernobyl accident, safety issues during the operation of nuclear installations are of great importance. The nuclear fuel loading into the reactor of the first Belarusian NPP power unit started on August 7th and then the physical start-up will be carried out. All stages of work affecting safety must be performed accurately, carefully and meaningfully.

For a long time JIPNR-Sosny (hereinafter referred to as the Institute) was the only organization in the country with experience in operating nuclear facilities. The Institute is the operator of Gyatinth and Krystall critical facilities, Yalina subcritical stand and the nuclear fuel storage facility.

Since 2011, the institute has been actively working on developing and improving Nuclear Security Culture (NSC) [1]. The popular scientific publications on the culture of nuclear security have been prepared for all interested specialists. At the end of 2020, a training center will be opened for specialists regular training. Under the contract between the scientific institution JIPNR-Sosny, the United States Department of Energy (U.S.-D.O.E.), National Nuclear Security Administration (NNSA), Oak Ridge National Laboratory (ORNL) and Pacific Northwest National Laboratory (PNNL) a training program has been developed on the NSC, taking into account the commissioning of NPP. The seminar was held on the basics of a NSC for employees of the National Academy of Sciences of Belarus (JIPNR-Sosny), the Ministry of Energy of the Republic of Belarus (Belarusian Nuclear Power Plant), the Investigative
Committee, the Ministry of Internal Affairs of Belarus (MIA), the Ministry of Health of the Republic of Belarus.

2. The nuclear security culture at the JIPNR-Sosny

Maintaining the security of nuclear facilities is an integral part of the national security of any country with a nuclear infrastructure, and it requires continuous monitoring, analysis and improvement, taking into account modern achievements of science and technology.

Various protection systems are created to ensure the safe and secure operation of nuclear facilities and each of them is designed to thwart specific safety and security threats. Examples of such systems include safety systems: a system for accounting and control of nuclear material, a physical protection system, etc. Generally, a security system is defined as a combination of relevant technical structures, equipment and software, a set of administrative and technical controls (regulatory documents, technological regulations, protocols, etc.), as well as personnel implementing these controls.

Traditionally, the focus is on the physical protection system as the key element designed to determine and neutralize possible sabotage and terrorist acts, other illegal intrusion into a nuclear facility and proliferation of nuclear materials, any kind of interference in the technological process by unauthorized individuals and unskilled personnel [2].

Physical protection systems are designed to prevent unacceptable consequences resulting from malicious acts. The more serious possible consequences are, the more important it is to ensure a high degree of confidence that the physical protection systems will function effectively as designed. Malicious acts involving nuclear material and nuclear facilities can lead to a number of unacceptable radiological consequences and can threaten the non-proliferation regime.

Security culture plays an important role in ensuring the real effectiveness of the nuclear facility's security systems, since it is the people (their understanding of the reality of the threats and personal responsibility for their own well-being and the public good) that determine the quality of the security measures implemented and how well the procedures and regulations are followed [1]. According to the former director of the Office for Security and Emergency Operations at the US Department of Energy, General Eugene Habiger, “good security is 20% equipment and 80% people” [3].

At the initial stage of implementing a nuclear security culture into the Institute activities, the composition of the Coordinating Council for the NSC (hereinafter referred to as the Council) was determined. The Chairman of the Council was appointed and Council composition was approved by order of the Director General. Additionally, the Regulation on the Coordinating Council was developed and the Council Activity Plans for 2010 and 2011 was drawn up.

A program of activity on the NSC was developed and the Institute employees were informed about the program at the general meeting of the labor collective. In addition, the personnel of the nuclear physics facilities were informed about the program for enhancing the nuclear security culture being implemented at the Institute, the functions and responsibilities of the Coordinating Council, and representatives for communication.

The Council has become the coordinator for the implementation of the nuclear security culture in the Institute’s departments (figure 1).
The Council carries out activities aimed at improving the quality of work in the field of accounting, control and physical protection of nuclear materials maintained on the property and under the control and custody of the Institute.

In carrying out these activities, the Council is guided by the principles of a nuclear security culture as it is set forth in IAEA publication 1347, Nuclear Security Series № 7. Since 2010, training seminars on the NSC have been held in the Institute’s departments. Once a quarter, the Council meetings are held and progress reports are prepared. For new employees hired by the Institute, informational materials on the NSC have been prepared. Since 2011, the Institute has published information sheets regarding world events in the field of nuclear energy development and an analysis of events related to the nuclear security culture. Much work has been done to create a Code of Conduct in the field of NSC. Additionally, a number of measures have been taken to increase the level of the NSC:

- a management system for the NSC at the Institute has been developed and approved in accordance with the established procedure with the definition of duties, responsibilities and rights of individual officials and structural departments involved in the activity related to nuclear materials, sources of ionizing radiation and its physical protection;
- scheduled plans, notes on NSC have been developed and approved;
- trainings and seminars on NSC have been conducted with the Institute employees and heads of structural departments involved in the handling of nuclear materials, sources of ionizing radiation and its physical protection;
- methodologies for assessing the level of nuclear security culture (ordinary employees, administrative personnel of different levels, control and activity management system) have been developed and adapted to the conditions of the Institute;

**Figure 1.** the Coordinating Council at JIPNR-Sosny.
• analysis and evaluation of the results of the work for six months, a year, etc. have been performed.

3. Nuclear Security Culture in Belarus
The first nuclear power plant in the country will be commissioned in the Republic of Belarus next year. In May 2020, nuclear fuel was delivered to the site of the Belarusian NPP, and the NSC issues became relevant for a number of state ministries and departments. These works significantly increase the list of interested specialists from various state ministries and departments such as the Ministry of Energy of the Republic of Belarus (Belarusian Nuclear Power Plant), the Investigative Committee, the MIA, the Ministry of Health of the Republic of Belarus, and the Ministry of Health.

The importance of implementing measures to identify and suppress the activities of internal violators is enshrined at the legislative level in the Republic of Belarus. Any object using atomic energy in the Republic of Belarus is obliged to provide physical protection of nuclear materials and facilities, one of the components of which is the implementation of measures as part of a program to reduce threats from insiders [4, 5]. There are no clearly defined “standard” programs in our country, there are only fundamental laws governing activities in relation to physical protection. In particular, the Regulation on the physical protection of nuclear facilities, approved by the Decree of the Council of Ministers of the Republic of Belarus dated June 14, 2019 No. 385, in relation to verification measures of employees states:

“6. Providing and maintaining physical protection include:
6.15. creation of a system of selection and training, retraining and advanced training of employees (staff) of physical protection to achieve and maintain the level of qualification necessary to fulfill assigned functional duties and maintain a safety culture;
6.16. conducting verification activities in relation to citizens in connection with the provision of access to state secrets and in order to determine whether they can carry out work with nuclear materials, work at nuclear facilities and (or) at nuclear material storage facilities;
6.17. conducting verification activities in relation to employees of operating organizations and persons applying to occupy the positions of operating organizations, employees of other organizations involved in the activities of the operating organization, including ensuring the protection, defense, transportation of nuclear materials, spent nuclear materials, operational radioactive waste, fire safety and emergency response, work and (or) the provision of services in the course of activities related to the use of atomic energy, as well as other persons who intend to visit nuclear sites and storage facilities for nuclear materials, to detect information about the possibility of causing harm to the national security of the Republic of Belarus.”

As part of the implementation of the task in the field of nuclear security, the Institute carries out a range of measures aimed at reducing the likelihood of internal violators activity, early detection of potential internal violators and preventing from causing harm [6]:

• the training center was established
• the course “Nuclear Security Culture” have been developed
• seminars and trainings are held
• the questionnaires are developed and the questionnaires are being conducted
• guidelines «Application of behavioral approach for reduction of insider threats for physical protection of nuclear facilities»
• monograph «Human Resource Management in Nuclear Safety»
• monograph «Cyber security for physical protection at nuclear facilities»

3.1. The Course “Nuclear Security Culture”
Program of the course include:

• Overview of the fundamentals of nuclear security culture.
• Discussion of likely threats and consequences, impact of human factor on nuclear safety, nuclear security culture concepts, key elements of program of systematic enhancement of nuclear security culture level, enhancement of nuclear security culture level.
• Analysis of existing data for a deeper understanding of the nuclear security threats and consequences of the ineffective application of measures to ensure nuclear security.
• Analysis of human factor impact on nuclear safety effectiveness with the aim of improvement of the quality of staff actions.
• Analysis of the definition, core concepts and benefits of the nuclear security culture program, as well as explanation of the contribution which might be made by individual employees for NSC improvement.
• Characteristics of the key elements of the program of systematic improvement of NSC level and possible approaches to the program implementation within the framework of one or another interested organization for enhancement of the effectiveness and quality of nuclear security.

3.2. Seminars and trainings
Activities on nuclear security culture enhancement are regularly carried out at the Institute. The American experts are invited several times a year to conduct workshops and training activities aimed at increasing of awareness about existence of real nuclear security threats, enhancing security awareness of the personnel when performing their duties. Under the contract between the scientific institution JIPNR-Sosny, the U.S.-D.O.E., NNSA, ORNL and PNNL:
• in January 2019, specialists from the Oak Ridge National Laboratory held a seminar at the JIPNR-Sosny on the basics of a nuclear security culture for employees of the National Academy of Sciences of Belarus (JIPNR-Sosny), the Ministry of Energy of the Republic of Belarus (Belarusian Nuclear Power Plant), the Investigative Committee, the MIA, the Ministry of Health of the Republic of Belarus, and the Ministry of Health.
• In April 2019, experts from the Oak Ridge National Laboratory, Y-12 National Laboratory, Lawrence Livermore National Laboratory (all U.S.-D.O.E. facilities) held a seminar at the JIPNR-Sosny to reduce the threat from an internal threat. The workshop was attended by specialists of the JIPNR-Sosny, the Ministry of Energy (Belarusian Nuclear Power Plant), the Department of Security of the Ministry of Internal Affairs of the Republic of Belarus, and the State Security Committee.
• in July 2019, a training was held on the course “Fixed Object Safety” at the U.S.-D.O.E. National Training Center located in Albuquerque, New Mexico, USA;
• in September 2019, a working meeting was held on the topics of Cybersecurity Program and Analysis of the movement path of an intruder;
• in September 2019, a meeting of employees of the scientific institute JIPNR-Sosny was held with an American group of experts on ensuring personnel reliability. This meeting discussed approaches to determining personnel reliability in the United States and Belarus, as well as issues of further cooperation in all interested areas, including in the field of improving the culture of nuclear security;
• in October 2019 the JIPNR-Sosny, experts from the U.S.-D.O.E. ORS Management Group: Michael Allen Henry, Physical Protection Specialist, PNNL; Debra Ellen Day, Technical Training Specialist, PNNL, conducted a training course on the practice of developing training materials for the training of specialists in radiological safety and physical protection;
• in November 2019 an American expert group from PNNL held a seminar at the JIPNR-Sosny entitled “Responding to incidents related to radiological security”. Specialists of the JIPNR-Sosny, the Ministry of Energy (Belarusian Nuclear Power Plant), the Department of Security of the Ministry of Internal Affairs of the Republic of Belarus, and the State Security Committee were invited to the training;
• in January 2020 the meeting of the JIPNR-Sosny employees and American group of experts was held to review reports provided by the Institute, discuss measures taken to train security forces in 2019, plan further cooperation in training security forces, and also support issues for the nuclear security training program at the Institute were discussed;
• in January 2020, a seminar on reducing the threat from the internal intruder was held. Experts from the U.S.-D.O.E. (Pacific Northwest National Laboratory, Livermore National Laboratory, Oak Ridge National Laboratory) conducted training for specialists from the MIA, the Department of Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus (regulatory body in the field of nuclear and radiation safety in the Republic of Belarus), the Belarusian Nuclear Power Plant (operating organization).

3.3. Popular science publications

3.3.1 guidelines "Application of behavioral approach for reduction of insider threats for physical protection of nuclear facilities". Based on the materials provided by the American experts, as well as on their training on the subject of reaction to insiders, the scientific institution «JIPNR – Sosny» has developed and issued guidelines "Application of behavioral approach for reduction of insider threats for physical protection of nuclear facilities" in collaboration with the Institute of the National Security of the Republic of Belarus. The guidelines will later be used by the employees of not only the Institute but also other organizations and offices concerned. The edition considers the behavioral approach to mitigating the threats of violating the physical protection of facilities by insiders, the principle of relationships and behavior patterns of individuals at nuclear power facilities.

Insider threats create problems for physical protection systems that are radically different from outside threats. Insiders can take advantage of the fact that they have access rights, supplemented by their authority and knowledge of the facility, to bypass special elements of physical protection or other implemented controls, such as material protection, control and accounting measures, operational controls and procedures.

In addition, as employees with privileged access, working in positions of trust, insiders can use such means to cause damage that are unavailable to outside adversaries as they have to deal with physical protection elements and access control measures. Insiders have more opportunities to choose the most vulnerable target and the most favorable time to commit their malicious acts and many other advantages (including established relations with nuclear facility personnel and knowledge of coworkers’ psychological characteristics).

Many psychological and behavioral aspects of insider threat mitigation efforts at nuclear facilities are difficult to assess and predict by the leadership and security services without special training. Therefore, the legal and psychological support of preventive measures and decision-making in response to potential insider threats using clear behavioral insider patterns (profiles) is an extremely important scientific and practical task.

These guidelines are an attempt to solve this problem by creating insider profiles using the behavior science approach.

3.3.2 Monographs «Human Resource Management in Nuclear Safety» and «Cyber security for physical protection at nuclear facilities». The edition considers the behavioral approach to mitigating the threats of violating the physical protection of facilities by insiders, the principle of relationships and behavior patterns of individuals at nuclear power facilities [7-9].

To ensure the safe and secure operation of nuclear facilities, various protection systems are created, and each of them is designed to thwart specific threats to safety and security. Examples of such systems include safety systems, a system for accounting and control of nuclear material, a physical protection system, etc. As a rule, a security system is defined as a combination of relevant technical structures, equipment and software, a set of administrative and technical controls (regulatory documents, technological regulations, protocols, etc.), as well as personnel implementing these controls.
A review of incidents, emergencies and cyber attacks at nuclear facilities is presented in the work.

For greater clarity and validity of the proposed methodological solutions, the guide first analyzes traditionally established approaches to determining the profile of individuals committing security infractions at nuclear facilities with directions for their improvement, with due consideration of modern developments. There is also an overview of a number of case studies associated with the theft of nuclear material and protected information, examples of emergency situations and cyber attacks at nuclear facilities indicating the root causes and consequences, as well as the role of inside and outside adversaries. Specific psychological profiles of potential offenders are suggested, as well as measures to identify malicious insiders. The appendix contains methodological tools (a sample checklist with signs of insider behavior) that can be used as the basis at a specific nuclear power facility.

4. Conclusions

The Scientific Institution “JIPNR – Sosny” recognizes the need to address the insider threat to protect nuclear materials at the Institute, and at facilities across the Republic of Belarus. The Institute has been actively cooperating with the U.S. National Nuclear Security Administration to improve nuclear security culture, increase awareness of insider threats, upgrade nuclear materials physical protection system and anti-terrorism and anti-sabotage security of their storage places, and initiate a program to mitigate insider threats.

1. The above-mentioned measures enable achievement of the aim when the managers of all levels and certain employees remain vigilant and activities are regularly carried out to prevent and manage threats of harm or radioactive material usage for malicious purposes.

2. High level of nuclear security culture enhances probability of detection, severity of consequences, balance of consequences and potential profit, as well as improves hindrances and reduces probability of malicious insider actions.

3. «The management should not choose between techno-centered and human-centered projects of the physical security system. On the contrary: physical security is the result of cooperation of technologies, culture and people. One of the prime tasks of the physical security culture is assistance to the cooperation of humans and technologies in the systems crucial for the physical security in such a way as to help personnel detect problems, define forthcoming events and foresee factors which will result in physical security breach. The more complex technologies and measures of the physical security are, the higher is importance of the people who design, operate, maintain and update technologies» [9].

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