RISK INFORMED APPROACH TO THE SECURITY OF RADIOACTIVE SOURCES IN USE AND IN STORAGE IN PAKISTAN

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Abstract

Radioactive Sources are used in various areas such as research, medicine, industry, agriculture and education for wide range of applications in Pakistan. Stringent security measures are in place for secure use, handling, and storage of radioactive sources and to protect against any malicious act resulting in radiological hazards, having undesirable consequences for public, property, society and environment. Security measures are applied according to associated risk, in line with "IAEA Nuclear Security Recommendations on Radioactive Material and Associated Facilities (NSS-14)", "IAEA Nuclear Security Implementing Guide on Security of Radioactive Sources (NSS-11)" and "National Regulations on Security of Radioactive Sources (PAK-926)." To minimize risk, Pakistan Atomic Energy Commission has developed an in-house self-assessment programme for accountability and control of radioactive sources. The paper describes risk informed approach for secure management of radioactive sources in-use and in-storage. A recovery mechanism is in place to cater loss of regulatory control of radioactive sources in-use and in-storage. Moreover, certain measures are adopted for risk reduction for disused sealed radioactive sources kept in interim storage in Pakistan.
Keywords: Risk Assessment, Risk Minimization, Threat Assessment, Radioactive sources, Secure Management

1. INTRODUCTION

Radioactive Sources have wide range of applications including research, medicine, industry, agriculture and education. Secure management of these sources during their complete life cycle is ensured to avoid any radiological accident. After 9/11, threat scenarios have changed globally and in this perspective, due importance is assigned to security of radioactive sources worldwide. For this purpose, the IAEA Incident and Trafficking Database (ITDB) is an international platform to report incidents of radioactive sources which have been missing, stolen, in unauthorized use and in unauthorized possession etc. This database is helpful in understanding risk scenarios related to radioactive sources and provides us some examples to improve security of radioactive sources. Pakistan voluntarily participates in IAEA ITDB program and continues to support its objectives.

For implementing the risk informed approach, it is very important to understand the two terms i.e. threat and risk and the relation between risk and threat.

- *Threat*: A person or group of persons with motivation, intention and capability to commit a malicious act. *A threat is what we're trying to protect against.*
- *Vulnerability*: Weakness of an asset or control that can be exploited by a threat.
- *Risk*: The potential for an unwanted outcome resulting from a nuclear security event as determined by its likelihood and the associated consequences.

Accurately estimating the likelihood of threats and identifying vulnerabilities is critical to understanding the risk to assets. The formula used to measure Risk is Risk = Consequences x Likelihood.

The risk informed approach is an iterative process that identifies and assesses threats and risks, and develops, evaluates and implements alternatives, and monitors and manages the resulting actions for relevance and effectiveness. This approach is adopted because it is helpful in allocating resources more effectively and efficiently at national level by systematically considering the threats and risks.

Risk informed approach is necessary to avoid any malicious act related to radioactive sources leading to undesirable consequences. A state's physical protection system is designed for secure use of radioactive material based on following four steps to address threats [1].

- The identification of threats
- The identification and assessment of targets and consequences
- The assessment of threats and risks
- The use of risk informed approach to prioritize nuclear security systems and measures

2. IMPLEMENTATION OF RISK-INFORMED APPROACH - PAKISTAN'S PERSPECTIVE

Pakistan has voluntarily subscribed to IAEA's non-binding instrument, the Code of Conduct on the Safety and Security of radioactive sources [2]. Pakistan's nuclear security policy for radioactive sources is based on the code and detailed as follows.

2.1 Methodology for Addressing Risk-Informed Approach

The national nuclear security regime assigns the competent authority responsible for identifying risks and fostering cooperation and coordination among all involved entities. National competent authority performs threat assessment for identification of risks associated with radioactive sources in use and storage. For developing and implementing the national nuclear security policy and strategy, an appropriate legal and regulatory framework has been developed. The outline given in NSS No. 24-G [1], the internationally harmonized guidance, can also be used to improve risk-informed approach for security of radioactive sources.

2.2 Development of National Regulations

At national level, all potential threats, related potential consequences and likelihood of malicious acts are assessed. In this perspective, a legislative and regulatory framework is in place for efficient and effective security of radioactive sources in use and in storage to address all possible threats. Pakistan established an independent regulatory authority (Pakistan Nuclear Regulatory Authority-PNRA) which is regulating the safe and secure management of radioactive sources in use and storage in Pakistan. PNRA has developed "National Regulations for Security of Radioactive Sources" - PAK/926 [3] consistent with IAEA Code of Conduct on the Safety and Security of Radioactive Sources [2] and IAEA recommendations for security of radioactive sources. PAK/926 consists of a set of security requirements for radioactive sources considering risk-informed approach. PNRA periodically evaluates the security measures in place for radioactive sources in use and in storage, taking into account all possible risk scenarios.

2.3 Application of Security Measures According To Risk

The IAEA's methodology for categorization of radioactive sources [4] is adopted to follow an internationally harmonized basis for risk informed decision to apply a graded approach to the regulatory control of radioactive sources for security purposes. Security levels based on categories, including aggregation of sources in a given location as appropriate, are also checked to assess the specification of security system. These security levels are defined in PAK/926.

High risk-associated sources such as Category 1 and Category 2 sources are assigned security measures which meets the security objectives of security level A and security level B respectively. Medium risk-associated sources such as Category 3 sources conform to security level C objectives, whereas Security level D is adopted and implemented for protection of category 4 and 5 SRS. Moreover, submission of a physical protection plan for high and medium risk radioactive sources is warranted by PNRA for acceptance. This plan is prepared in consultation with the concerned security elements, in accordance with the format and specified contents. The physical protection plan is tested and evaluated at regular intervals. Using risk informed approach, the physical protection system is enhanced with the change in threat and notified to PNRA.

A physical protection system is designed, evaluated and implemented to achieve system effectiveness on the basis of such assessments which enable countries to manage the risk and to assign priorities in allocating resources to organizations and to nuclear security systems and measures.

The physical protection of radioactive sources in use and in storage at nuclear medical centers is being enhanced and is in implementation phase. The design of the installed physical protection system is according to international harmonized guidance i.e. IAEA Nuclear Security Implementing Guide - Security of Radioactive

Sources NSS-11 [5] and national regulations PAK/926[3]. Radioactive Sources, used for cancer treatment at these facilities, are high risk-associated sources falling in category-1 and category-2 by application and requires detection, delay, and response measure of security level A and level B respectively. As a heightened security measure to address prevailing risk, multiple monitoring stations in addition to the security control room have been established at each of these centers for early detection and to enhance capabilities for immediate response. In addition, there is provision in the security control room for generation of automatic notification of arming/disarming of security system through redundant and diverse means.

3. SELF-ASSESSMENT PROGRAMME FOR ACCOUNTABILITY AND CONTROL OF RADIOACTIVE SOURCES IN-USE AND IN-STORAGE IN PAKISTAN

Pakistan Atomic Energy Commission (PAEC), being the major operator for radioactive sources in Pakistan, is exercising an in-house self-assessment programme for accountability and control of radioactive sources in use and in storage in order to ensure compliance of national regulations. On the basis of national regulations and IAEA recommendations, physical protection systems and measures are developed and implemented for prevention of, detection of, and response to criminal or intentional unauthorized acts directed at radioactive sources. Security of radioactive sources is ensured throughout its complete life cycle. Any movement of radioactive sources within the country is done with prior approval of PNRA. All efforts are made to protect radioactive sources by ensuring provision of adequate allocation of resources to all stakeholders.

Technical and administrative security measures are undertaken in support of PAEC's accountability and control program for security of radioactive source in-use and in-storage. Measures taken against Physical Protection System (PPS) functions of detection, delay and response for the security of radioactive sources are evaluated according to national regulations PAK/926. Salient technical measures are as follows:

- Electronic Access Control System
- Intrusion Detection System
- Provision of access delay barriers (Secure Containers, Secure Enclosures, Robust Doors)
- Tamper Indication Devices (TIDs)
- Scheduled and breakdown maintenance of PPS equipment and system
- Robust containments for storage of radioactive sources
- Provision of compensatory measures in case of temporary equipment or system failure
- Performance testing of physical protection system

For accounting of radioactive sources in-use and in-storage, certain administrative measures are in place to complement technical measures, which primarily include:

- Physical protection plan
- Event reporting plan
- Security contingency and implementing procedures
- Procedures for access control and key issuance
- Assessment, Surveillance and monitoring by guards
- Alarm Assessment and Response Procedures
- Procedures for facility access during operational and non-operational hours
- Procedures for temporary storage of disused radioactive sources
- Arming and Disarming the security system
- Human Reliability and trustworthiness program
- Sensitive information security
- Quality assurance measures
- Capacity Building Procedures
- Measures for fostering security culture

The provision and effectiveness of these measures are evaluated and Areas for Improvement (AFIs) are highlighted to facility management. Follow up is also conducted, to verify implementation of recommendations, at specified periods.

4. PREVENTION, DETECTION, RESPONSE AND MITIGATION MEASURES

A nuclear security event includes loss of control over radioactive source, unauthorized access or removal of the source and sabotage activity. A search and recovery mechanism is in place in case a radioactive source in-use and storage has been declared as lost. It includes deployment and mobilization of resources for identification and recovery of lost sources - to provide means to address the risk of sabotage.

At the national level, to prevent unauthorized possession, use, storage, or movement of radioactive sources, certain measures have been implemented for early detection of radioactive sources out of regulatory control. Major entry/ exit points of the country are being equipped with radiation detection equipment. An integrated cargo container control facility has been established at Port Qasim near Karachi since 2007. This port is CSI (Container Security Initiative) compliant. PAEC/PNRA have established emergency support mobile labs, adequately equipped to respond to various contingencies related to nuclear safety and security events at different locations in Pakistan. For interior detection architecture, Pakistan is equipping its response organizations with radiation detection equipment for detection and initial response to nuclear security incident / event. On-site Radiological Assessment Groups (RAG teams) have been established to assess, in case of an event, the radiological hazards, provide radiation protection for the first responders and make recommendations to the on-scene controller on protective actions, isotope identification of unknown sources, surface contamination checks, search operations for radioactive sources out of regulatory control.

Nuclear Emergency Management System (NEMS) is a coordinating body mechanism which has been developed at national level to respond and manage nuclear or radiological emergencies. The objective of NEMS is to bring all stakeholders on board to address any sort of nuclear or radiological emergency. Under NEMS, technical provisions would be met by PAEC and PNRA, which would be supplemented by administrative coordination by National Disaster Management Authority (NDMA); while the national competent authority would offer all necessary resources in case of any radiological emergency. NEMS operates through Nuclear and Radiological Emergency Support Centre (NURESC). It is the focal point at national level to deal with entire spectrum of nuclear and radiological emergencies. NURESC coordinates and facilitates activities of its geographically deployed tools which include: Radiological Assistance Groups, Hazard Assessment and Advisory Teams, Aerial Survey and Surveillance Teams, and Radiation Medical Assessment Teams.

National Radiation Emergency Coordination Centre (NRECC) coordinates for the response to nuclear accidents or radiological emergencies, both nationally and abroad. NRECC is a fully functional national focal point to address nuclear security events related to radioactive sources in-use and in-storage in order meet national and international obligations under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. It has provision of redundant and diverse communication channels, radiation detection equipment, personnel protective equipment, mobile radiological monitoring laboratories and technical support teams.

PAEC Emergency Response Coordinator Center (PERCC) has been established at headquarters which enhances the capability to respond to nuclear security events. This centre operates round the clock, 365 days a year. It deals will all sorts of emergencies as well as nuclear security events related to radioactive sources in-use and in-storage under the custody of PAEC. It has an interface with PNRA and other organizations working under the umbrella of National Nuclear Emergency Management System (NEMS). Essential data from the affected radioactive sources associated facility is available for evaluation in the center.

5. RISK MINIMIZATION FOR DISUSED SEALED RADIOACTIVE SOURCES (DSRS) IN INTERIM STORAGE IN PAKISTAN

Disused Sealed Radioactive Sources (DSRS) are being managed in Pakistan by either returning to manufacturer or by keeping in interim storage. In accordance with PNRA regulations, for SRS having half-life greater than one year and initial activity of 100 GBq or more, it is binding upon the supplier to provide an undertaking to accept the return of these SRS when they are no longer useful for their intended purposes. A no-objection-certificate is issued by the national regulator, only upon fulfilment of this condition.

For risk reduction, special arrangements have been made by selecting multiple sites for interim storage of DSRS. There are two interim storage facilities for the storage of disused SRS in Pakistan. One is located in northern part of Pakistan at Pakistan Institute of Nuclear Science and Technology (PINSTECH), Islamabad

which covers Punjab, Khyber PakhtunKhwa provinces and Capital territory while the other is in southern part of the country at Karachi Nuclear Power Plant (KANUPP) for Sindh and Balochistan Provinces. The corporate security office acts as focal coordinating point for the interim storage of disused SRS from all PAEC facilities. On the receipt of request for interim storage of disused SRS from the facility, the corporate security office coordinates with interim storage facility and remains on board until the completion of whole activity. The arrangement for temporary storage of orphan source found (if any) is also carried out in coordination with PNRA in same interim storage facilities.

6. CONCLUSION

Threat is determined by identification of material, adversaries, and tactics, which provides a basis for risk assessment. After risk assessment, physical protection system is designed for implementation of corresponding security measures according to specific risk. Potential systems and measures are identified which are deployed to reduce risk from any malicious act having nuclear security implications. These systems include various prevention, detection, response and mitigation measures which are implemented for risk reduction regarding security of radioactive sources in-use and in-storage. Pakistan has adopted comprehensive measures to ensure security of radioactive sources in-use and in-storage in line with IAEA guidance and national regulations, thereby achieving effectiveness of risk informed approach for security of radioactive sources in use and in storage. It aims to progress on similar lines and continually develop and enhance its nuclear security regime.

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