USING A GRADED APPROACH IN THE OVERSIGHT OF SECURITY AT NRC-LICENSED RESEARCH REACTORS

E. REED
U.S. Nuclear Regulatory Commission
Rockville, MD
Email: Elizabeth.reed@nrc.gov

Abstract

The NRC licenses and provides oversight of the civilian use of special nuclear materials (SNM) used at research reactors. Regulatory oversight seeks to protect public health and safety, promote the common defense and security, and protect the environment. The existing SNM physical protection regulatory requirements at research reactors are graded using a material categorization approach similar to that found in "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities" (INFCIRC/225/Revison5). The application of a graded approach is essential given the wide diversity among the regulated community of research reactors. The NRC regulates 31 research reactors, some are located on federal government campuses, some are privately owned, but most are located at universities. While some of the university research reactors are located off campus in remote locations, many are in classroom buildings in the middle of campus. The regulations identify requirements for physical protection of SNM, depending on its Category, using a defense is depth approach. The ease of separability of SNM from other radioactive materials and external radiation levels is also considered to a varying degree in assigning different physical protection requirements or in exempting certain materials from physical protection requirements. Finally, security requirements are applied based on power level, with research reactors of higher power level requiring additional measures to protect against sabotage This paper will discuss the NRC regulatory framework as it applies to research reactors and their unique environments. It will also show how the NRC applies security requirements on a site-specific basis using a graded approach. The presentation will also discuss lessons learned and effective practices identified regarding the implementation of regulations and interagency initiatives as they apply to research reactors. Some of which were highlighted in 2013 when the NRC hosted an International Physical Protection Advisory Service Mission (IPPAS).

1. INTRODUCTION

There are 31 research reactors currently licensed to operate by the U.S Nuclear Regulatory Commission that encompass a multitude of designs, locations, and purposes. These research reactors are located in a variety of different locations ranging from university campuses to military bases. Applying one-size fits all approach to regulations could result in requirements for protecting against malicious activities that would either be too strict, or not strict enough. Therefore, the U.S. Nuclear Regulatory Commission uses a graded approach in its regulatory framework for the oversight of licensed activities, to include research reactors. The U.S. Nuclear Regulatory Commission's application of a graded approach considers several attributes, including the type of reactor, the power level of the reactor, the quantity and form of the special nuclear material possessed by the reactor, the purpose of the reactor, and the location or the reactor.

2. LEGAL AUTHORITY REQUIRING A GRADED APPROACH

Regulating research reactors by graded approach was first established in Section 104 of the Atomic Energy Act as amended [1], which requires the U.S. Nuclear Regulatory Commission apply the concept of minimum regulation to non-commercial research reactors useful in the conduct of research and development. The Atomic Energy Act states that the Commission is directed to impose only such minimum amount of regulation on the licensee as the Commission finds will permit the Commission to fulfil its obligations under this Act to promote the common defence and security and to protect the health and safety of the public and will permit the conduct of widespread and diverse research and development The U.S. Nuclear Regulatory Commission applies this requirement for minimum regulation in all aspects of the regulation of non-commercial research reactors, including security.

The fundamental need and concept of grading for nuclear security was in the Atomic Energy Act of 1954, as amended. Section 53 of the AEA states, in part, "the Commission shall establish, by rule, minimum criteria for the issuance of specific or general licenses for the distribution of special nuclear material …" and "is authorized to establish classes of special nuclear material and to exempt certain classes or quantities of special nuclear material or kinds of uses or users not inimical to the common defence and security and would not constitute unreasonable risk to the health and safety of the public."

The U.S Nuclear Regulatory Commission has codified requirements for the physical protection of special nuclear material at U.S Nuclear Regulatory Commission licensed facilities in Title 10, "Energy," of the Code of Federal Regulations (10 CFR) Part 73, "Physical Protection of Plants and Materials" [2]. The regulations incorporate a grading of categories of special nuclear material physical protection requirements using a three-tiered categorization approach. The resulting special nuclear material I, II and III categories are consistent with recommended levels in the International Atomic Energy Agency's INFCIRC/225 [3].

3. UNIQUE CHALLENGE OF RESEARCH REACTORS

Research Reactors represents a diverse category of research, training, and teaching facilities that can be co-located with other facilities. Along with the research reactor, other facilities could include radioisotope production facilities, storage of fresh fuel, spent fuel storage, use or storage of radioactive sources, research or teaching laboratories, hot cells, irradiation facilities, other non-nuclear related facilities and activities. Research reactors encompass a multitude of designs, functions, and power levels. The challenge is to adequality secure the reactor and its materials without impeding on education, research, and training.

Operating budgets at these facilities are typically limited therefore the role of the reactor security director is commonly held by someone who has other duties; such as teaching, conducting research, or supervisor of operations. This person may also not have much experience, or training, in security principles but rather is employed as a nuclear engineer. Often, there is little room in the budget for the purchase of sophisticated security equipment, and full-time security personnel. Security measures must be sustainable and easily maintained, with reliable backups, and scaled or graded to meet the security risk.

The reactor facility usually doesn't employ a security force, but rather relies on campus police or offsite local law enforcement to respond to alarms and investigate incidents. Response forces are often shared with other facilities in the area such as banks, schools, or industrial complexes, and therefore may not be available for immediate response. U.S Nuclear Regulatory Commission licensees have been directed to develop Memorandum of Understanding with offsite local law enforcement agencies to ensure response forces arrive in a timely manner. Every facility conducts periodic exercises with these security forces to ensure that a fast and effective response to any incident can be provided.

3.1. Reactor Type, and Power Level

The power levels of the 31 research reactors licensed by the U.S Nuclear Regulatory Commission vary significantly. Thermal power levels and designs range from a 5-watt AerojetGeneral Nucleonics (AGN) solid homogeneous fuelled reactor to a 20-megawatt heavy-water-cooled and -moderated tank-type facility. Training, Research, Isotope-Production, General Atomics (TRIGA) reactors are the most common design regulated by the U.S Nuclear Regulatory Commission. The TRIGA reactors are open pool-type and are typically installed without a containment building, but rather a confinement building. A few of the facilities that use a TRIGA reactor are designed with a movable core.

3.2. Quantities of Special Nuclear Material

Research reactors that are licensed by the U.S. Nuclear Regulatory Commission have possession limits of Category II or Category III. These categories are consistent with those found in INFCIRC/225/Revision 5. Approximately two-thirds of the research reactor facilities are licensed to possess Category III special nuclear material in the form of irradiated reactor fuel. A very small number of research reactor facilities possess fresh fuel for a small amount of time in preparation for refuelling.

3.3 Locations

The locations of the research reactors are as varied as their power level and design. While most of the research reactors are located on university campuses, there are a few located on government installation or military bases, and even a few that are privately owned. Of the research reactors located on a university campus, some are located offsite and not near the populated campus, but most are located in the middle of campus. Some are even located in a building with classrooms and lecture halls. An example of the diversity in location is that a few research reactors are situated next to the football stadium, which during football season can attract close to 100,000 people to a game. Fans attending the games may park their cars near the facility, walk past the facility, and may even hold celebrations after the game within 100 meters of the facility. Yet another facility is so far removed from the campus, staff at the reactor facility may see wildlife walk by the facility. The focus of the work done at the facility will often dictate its location. If the reactor is used for classroom instruction and training of future operators than the most likely location for the facility would be in a classroom building centrally located near other classroom buildings. If, however, the work focused more on research then the facility could be located remotely offsite and away from the populated areas.

4. IMPLEMENTATION OF A GRADED APROACH

The underlying rationale of the regulatory framework is that protective measures should be commensurate with the potential consequences of malevolent acts to the public's health and safety or to the common defense and security. The existing special nuclear material physical protection regulatory requirements at fixed sites and in transit are graded using a material categorization approach, similar to what is described in International Atomic Energy Agency, INFCIRC/225/Revision 5, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities."

The regulations in 10 CFR Part 73, "Physical Protection of Plants and Materials," are written using a combination of performance-based and prescriptive approached. Using performance-based regulations is a regulatory approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques, or procedures. Performance-based regulation leads to defined results without specific direction regarding how those results are to be obtained.

To guide licensee in applying the regulations the Commission has issued guidance in the form of Regulatory Guides. Regulatory Guides provide guidance to licensees and applicants on acceptable methods for carrying out specific parts of the NRC's regulations, techniques used by the NRC staff in evaluating specific problems or postulated accidents, and data needed by the staff in its review of applications for permits or licenses. Regulatory Guide 5.59, "Standard Format and Content of a Licensee Physical Protection Plan for Special Nuclear Material of Moderate or Low Strategic Significance" [4] describes the information required in the physical security plan submitted as part of an application for a license to possess, use, or transport Category II and Category III special nuclear material. The standard format serves as an aid to uniformity and completeness in the preparation and review of the physical security plan. Aside from providing guidance for the standard format and content of physical security plans, this regulatory guide explains the intent of the various provisions of the regulation. The intent of each requirement is found in the discussion of each subsection and is implicitly provided by outlining alternative systems that could be used to fulfill the requirements. The discussion section and list of alternatives provides the licensee with the sense of the NRC regulations.

Security related inspections are conducted for assessing facility performance, and adherence to the regulations. The inspection program is conducted on a graded approach, the facilities possessing the more risk significant material are inspected at a higher frequency than those possessing less risk significant material. Inspections ensure that necessary arrangements and agreements between off site responders and the facility operators are established and maintained. Performance based inspection of systems relied on for physical protection ensures that those systems are sustained through testing and maintenance.

4.1 Material Categorization

The existing material categorization approach places uranium and plutonium in one of three risk-informed categories: Category I, Category II, or Category III, depending on its type, quantity (i.e., mass), and enrichment for uranium 235. The regulations in 10 CFR Part 73, "Physical Protection of Plants and Materials" then identify requirements for physical protection of that special nuclear material depending on the category. Research reactors that possess larger quantities of special nuclear material or utilize material that is potentially more attractive to adversaries have more security measures in place.

The objective of the physical protection system for Category II and III materials is to minimize the possibility for unauthorized removal of special nuclear material and to facilitate location and recovery of missing special nuclear material. The U.S Nuclear Regulatory Commission's policy is not to require the physical protection systems of Category II and III facilities and non-power reactors to protect against the design basis threat of theft or diversion and radiological sabotage. Rather, for these facilities, the U.S Nuclear Regulatory Commission's policy is to require licensees to meet a set of requirements, the effectiveness of which have been evaluated based on U.S Nuclear Regulatory Commission threat assessments as well as consequence and security assessments for these facilities.

4.2 Power Level

In addition to regulations that require the prevention of the unauthorized removal of special nuclear material, there are regulations to protect against radiological sabotage. In 10 CFR 73.60(f) [5] "Additional Requirements for Physical Protection at Nonpower Reactors," states that the Commission may require alternate or additional measures to protect against sabotage for research reactors above 2 megawatts (thermal). For those research reactor that operate at 2 MW(t) or above, the licensee must protect against sabotage.

4.3 Exemptions

The ease of separability of special nuclear material from other radioactive materials and external radiation levels is also considered to a varying degree in assigning different physical protection requirements or in exempting certain materials from physical protection requirements. The regulations in 10 CFR 73.67(b) exempt a licensee from the requirements of 10 CFR 73.67 [6], "Licensee Fixed Site and In Transit Requirements for the Physical Protection of Special Nuclear Material of Moderate and Low Strategic Significance" for use and transport for (1) special nuclear material which is not readily separable from other radioactive material and which has a total external radiation level in excess of 100 rem per hour at a distance of 3 feet from any accessible surface without intervening shielding, (2) sealed plutonium beryllium sources totaling 500 grams, or (3) plutonium with an isotopic concentration exceeding 80 percent plutonium238. Also, the regulations in 10 CFR 73.67(d) and (f) exempt Part 50 licensees from the requirements in these sections.

5. SUPPLEMENTAL SECURITY MEASURES

Before the threat environment changed in the United States in 2001 the U.S Nuclear Regulatory Commission regulations adequately addressed the safe use, storage, and transport of special nuclear material. However, with the change in the threat environment the U.S Nuclear Regulatory Commission re-evaluated the adequacy of security at all U.S Nuclear Regulatory Commission licensed facilities. The Commission determined that licensees should implement new security requirements to enhance the protection of the facility and to mitigate potential consequence of radiological sabotage and theft. The Commission further determined that these requirements should be implemented through Orders as opposed to a rulemaking to expedite licensee implementation of the requirements.

Maintaining a risk informed graded approach to security, the Commission issued these orders to most licensees, but for research reactors the Commission issued confirmatory action letters rather than issuing security orders. The Commission first transmitted letters to each facility recommending implementing security measures that were site-specific and aligned with the characteristics of facility that was licensed. These security measures focused on the mitigation of potential radiological sabotage and theft events. Examples of enhanced security measures that were implement include, but not limited to, enhanced background screening, improved internal and external communication systems, and improved access control to key areas. Facilities that were lower power only had to address mitigating theft events since the consequences from radiological sabotage were minimal. Research reactors each voluntarily committed to implementing some, if not all, of the recommended security measures. Upon U.S Nuclear Regulatory Commission review and inspection of the adequacy of the agreed upon security measures, the Commission issued to each licensee their site-specific confirmatory action letter.

These supplemental security measures have since been incorporated into the facilities security plans. The security plans are a condition of the facilities operating license. Verification that these measures are followed is done during routine inspections.

After the implementation of these site-specific security measure the U.S Nuclear Regulatory Commission conducted a comprehensive security assessment at each individual research reactor. The assessments examined both theft and sabotage scenarios. Based on the results of the assessments the Commission concluded that the security posture at each facility adequately protected the public health and safety and promoted the common defence and security. The Commission determined that no new security regulations were required.

The assessments did however, offer licensees suggestions of effective practices. The Commission encouraged the licensees to review these and implement those applicable, if possible. Through a public private partnership council, as described in the Department of Homeland Security National Infrastructure Protection Plan [9], a voluntary security enhancement program was initiated. This program, through funding from the federal government, provided site-specific security enhancements that were both sustainable and easily implemented. This program also provided response force training and culminated with a table top exercise to reinforce training and communications amongst responders.

6. SUMMARY

A robust physical protection program at licensed research reactors is one that provides defense-in-depth through the integration of systems, technologies, programs, equipment, and supporting processes. Physical security strategies at these research reactors employ "defense-in-depth," and are founded on the "detect, delay, assess and respond" model. The regulatory framework used by the U.S. Nuclear Regulatory Commission is risk-informed, scaled to meet the unique features and characteristics of the research reactors, and complimented through Orders and voluntary commitments, as needed based on threat assessments. The U.S. Nuclear Regulatory Commission and its licensees work together to maintain a strong physical security program.

REFERENCES

[1] ATOMIC ENERGY ACT (as Amended), P.L. 83-703 (1954).

[2] CODE OF FEDERAL REGULATIONS, 10 CFR 73, "Physical Protection of Plants and Materials", https://www.nrc.gov/reading-rm/doc-collections/cfr/part073/

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, INFCIRC/225/Revision 5, "Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities." https://www.iaea.org/publications/8629/nuclear-security-recommendations-on-physical-protection-of-nuclear-material-and-nuclear-facilities-infcirc/225/revision-5.

[4] UNITED STATES NUCLEAR REGULATORY COMMISSION, Regulatory Guide 5.59, "Standard Format and Content for a Licensee Physical Security Plan for the Protection of Special Nuclear Material of Moderate or Low Strategic Significance", February 1983. https://www.nrc.gov/docs/ML1003/ML100341301

[5] CODE OF FEDERAL REGULATIONS, 10 CFR 73.60, "Additional Requirements for Physical Protection at Nonpower Reactors." https://www.nrc.gov/reading-rm/doc-collections/cfr/part073/part073-0060.html.

[6] CODE OF FEDERAL REGULATIONS, 10 CFR 73.67, "Licensee Fixed Site and In-transit Requirements for the Physical Protection of Special Nuclear Material of Moderate and Low Strategic Significance." https://www.nrc.gov/reading-rm/doc-collections/cfr/part073/part073-0067.html.

[7] UNITED STATES NUCLEAR REGULATORY COMMISSION, Security of Research and Test Reactors. https://www.nrc.gov/reactors/non-power.html#security.

[8] CODE OF FEDERAL REGULATIONS, 10 CFR 73.57, "Requirements for Criminal History Records Checks of Individuals Granted Unescorted Access to a Nuclear Power Facility, a Non-power Reactor, or access to Safeguards Information." https://www.nrc.gov/reading-rm/doc-collections/cfr/part073/part073-0057.html.

[9] National Infrastructure Protection Plan 2013: Partnering for Critical Infrastructure Security and Resilience https://www.dhs.gov/publication/nipp-2013-partnering-critical-infrastructure-security-and-resilience