UPDATE TO NRC DECOMMISSIONING ACTIVITIES RELATED TO NUCLEAR SECURITY

Vince Williams
United States Nuclear Regulatory Commission
Rockville, Maryland, United States
Email: vince.williams@nrc.gov

Shyrl Coker
United States Nuclear Regulatory Commission
Rockville, Maryland, United States

Brian Zaleski
United States Nuclear Regulatory Commission
Rockville, Maryland, United States

Abstract

During the last decade, several U.S. commercial reactors shut down prior to the expiration of their operating licenses which caused them to enter the decommissioning process for their facilities. The U.S. Nuclear Regulatory Commission's (NRC's) regulatory framework for security is designed for operating power reactors, which has historically not taken into account the different phases of decommissioning and the protection necessary for a facility that has ceased operations and defueled. To address this issue, the NRC is completing a rulemaking to adopt a graded approach for regulating security for facilities that transition to decommissioning. This rulemaking is designed to ensure that security requirements are commensurate with the radiological risk for these types of facilities. This poster will discuss the graded approach for security at commercial reactors that transition from operation to decommissioning, including the dry storage of spent nuclear fuel (SNF).

1. INTRODUCTION

Compared to that of an operating nuclear power reactor, the risk of an offsite radiological release at a nuclear power reactor that has permanently ceased operations and removed fuel from the reactor vessel is significantly lower, and the types of possible accidents are significantly fewer. However, the NRC's current regulations do not distinguish between the radiological risk that exists at a nuclear power reactor that has permanently ceased operations versus an operating nuclear power reactor. This has resulted in the need for the NRC staff to use exemptions and other regulatory tools to ensure requirements are appropriate for decommissioning plants. The NRC's current rulemaking initiative is designed to ensure requirements for decommissioning plants are aligned with the reduction in risk that occurs over time, while maintaining safety and security at commensurate levels. The rulemaking would improve the efficiency, openness, and predictability of the decommissioning process by reducing the reliance on licensing actions (i.e., license amendment and exemption requests) that have historically been used to ensure alignment between the regulatory requirements and risk to the public from a decommissioning plant.

Experience has demonstrated that licensees for decommissioning nuclear power reactors seek several exemptions and license amendments per site to establish a long-term licensing basis for decommissioning. This proposed rule would amend the current requirements for production and utilization facility licensees during decommissioning. Specifically, the decommissioning rulemaking would: (1) propose a regulatory regime that continues to provide reasonable assurance of adequate protection of public health and safety and the common defense and security at decommissioning sites; (2) ensure that the requirements for decommissioning are clear and appropriate; (3) adopt regulations to address generic issues applicable to all decommissioning nuclear power reactors that have historically been addressed through similarly worded exemptions or license amendments; and (4) identify, define, and resolve additional areas of concern related to decommissioning licensees under current regulations. Given that the current regulatory framework regarding decommissioning is adequate to protect public health and safety and the common defense and security, many of the new requirements proposed by this rulemaking are alternatives to the current requirements.

2. CURRENT REGULATORY PROCESS

A nuclear power reactor licensee formally begins the decommissioning process when it certifies its permanent cessation of operations and permanent removal of fuel from the reactor vessel. Once the NRC acknowledges the certifications for permanent cessation of operations and for the permanent removal of fuel from the reactor vessel, the power reactor licensee is no longer authorized to operate the reactor or place fuel in the reactor vessel. Despite this withdrawal of the authority to operate the reactor, a decommissioning nuclear power plant continues to retain its current license. For this reason, the decommissioning plant continues to be subject to many of the same requirements that apply to plants authorized for operation.

Many of the regulations that are designed to protect the public against design-basis events during reactor operation are no longer applicable at a permanently shutdown and defueled reactor. For example, certain accident sequences for an operating nuclear power reactor, such as loss of coolant accidents and anticipated transients without scram, are no longer relevant to a permanently shutdown and defueled reactor. In addition, some regulations may not be relevant to certain systems, structures, and components (SSCs) because the SSCs are no longer required to be maintained, to operate, or to mitigate certain accidents, events, or transients, regardless of whether they are safety-related or security-related SSCs. Other regulations, although based on power operation of the plant, may continue to be applicable to the permanently defueled facility for a limited time, such as the standards for offsite radiological emergency preparedness plans. Typically, the scope of NRC requirements can be reduced to those regulations and requirements that primarily pertain to the safe storage of the SNF in the spent fuel pool (SFP), as described in the site's final safety analysis report.

As discussed previously, the types of potential accidents at decommissioning reactors are fewer, and the risks of radiological releases are reduced, when compared to those at an operating reactor. To reflect this reduction in risk, licensees of decommissioning reactors typically request certain amendments to their licenses and certain exemptions from the NRC's regulations. These licensing actions, which are processed by the NRC during a licensee's transition from operating to decommissioning status, establish the regulatory framework for reactors that have permanently shut down and defueled.

The timing and implementation for some decommissioning licensing actions rely on an approach that recognizes the reduction in radiological risk after permanent cessation of power operation and removal of fuel from the reactor vessel. These risk reductions can be tied to several factors, including, but not limited to: (1) reduction of the radiological source term after cessation of power operation and removal of fuel from the reactor vessel, (2) elapsed time after permanent shutdown and the reduction in decay heat, and (3) type of long-term onsite fuel storage.

3. GRADED APPROACH

A graded approach is a process by which the safety and security requirements and criteria adjust during the decommissioning process commensurate with several factors. These factors include the magnitude of any credible hazard involved, the particular characteristics of a facility, and the balance between radiological hazards and non-radiological hazards (e.g., fire, flood, chemical spill) as applicable to specific points in time within the decommissioning process. This approach would be risk-informed. Currently, no explicit regulatory provisions distinguish requirements in several technical areas for a nuclear power reactor that has permanently ceased operations from those for an operating nuclear power reactor.

To address this, the NRC is proposing to amend its regulations in several areas to provide a regulatory framework for the transition from operating to decommissioning. This rulemaking presents a four-step graded approach that is commensurate with the reduction in radiological risk at four levels of decommissioning: (1) permanent cessation of operations and permanent removal of all fuel from the reactor vessel, (2) sufficient decay of fuel in the SFP such that it would not reach ignition temperature within 10 hours under adiabatic heatup conditions (i.e., a complete loss of SFP water inventory with no heat loss), (3) transfer of all fuel to dry storage, and (4) removal of all fuel from the site. The graded approach is a fundamental concept for this proposed rulemaking.

3.1. Graded approach – Level 1

Licensees in Level 1 include nuclear power reactor licensees that have submitted certifications of permanent cessation of operations and permanent removal of fuel from the reactor vessel. In this level, a decommissioning nuclear power reactor is defueled and permanently shut down, but the SNF in the SFP is still susceptible to a zirconium fuel cladding fire within 10 hours under adiabatic heat up conditions.

3.2. Graded approach – Level 2

In Level 2, the reactor is defueled and permanently shut down, and SNF in the SFP has decayed and cooled sufficiently such that it cannot heat up to the zirconium cladding ignition temperature within 10 hours under adiabatic conditions. The NRC has determined that this condition is reached after SNF has decayed for a minimum of either 10 months for a boiling water reactor (BWR) or 16 months for a pressurized water reactor (PWR) or an alternative site-specific timeframe to be approved by the NRC. The decay period could begin when the fuel is still in the reactor vessel, but after the reactor has permanently ceased operations. In order to verify that a licensee has met the condition, the NRC would rely upon the date of permanent cessation of operation provided by a licensee, updated as necessary.

Because the identified date of permanent cessation of operations would determine transition from Level 1 to Level 2, the NRC would consider a change in the planned date initially certified to the NRC for permanent cessation of operations to the actual date as information “having a significant implication for public health and safety or common defense and security.” At this point, the site may also possess a radioactive inventory of liquid radiological waste, radioactive reactor components, and contaminated structural materials. The radioactive inventory may change, depending on the licensee’s proposed shutdown activities and schedule.

3.3. Graded approach – Level 3

In Level 3, all SNF is in dry cask storage pursuant to the terms and conditions of a license granted under 10 CFR Part 72, including the general license issued in 10 CFR 72.210. However, the licensee may still hold a 10 CFR Part 50 or 10 CFR Part 52 license, and the site may contain a radioactive inventory of liquid radiological waste, radioactive reactor components, and contaminated structural materials.

3.4. Graded approach – Level 4

At this point in the facility’s lifecycle, all SNF has been removed from the site. The site may possess a radioactive inventory of liquid radiological waste, radioactive reactor components, and contaminated structural materials. The radioactive inventory during this configuration may change, depending on the licensee’s proposed decommissioning activities and schedule. As a facility transitions from being operational to having all SNF in dry cask storage, the proposed rule’s regulatory requirements are graded to provide for reasonable assurance of the health and safety of the public commensurate with the risk profile of the facility.

4. SECURITY FOR DECOMMISSIONING

The security risk profile presented by a decommissioning reactor decreases significantly from that of an operating nuclear power reactor due to the reduction in the number of combinations of equipment or operator actions which, if all are prevented from performing their intended safety function or prevented from being accomplished, would likely result in radiological sabotage. These sets of equipment and actions are known as “target sets.” The reduced number of target sets at a decommissioning reactor accordingly reduces the risk of radiological sabotage.

Further, the radiological consequences of a security event decrease as reactors transition through each of the four levels of decommissioning described in the Graded Approach section above. The security approaches that have been used for decommissioning sites have typically employed a graded approach based on those four levels (Figure 1).

The NRC is proposing options to allow nuclear power reactor licensees to make certain commonly requested changes to their physical security plans based on these decommissioning levels without requesting exemptions, alternative measures, or license amendments.

FIGURE. 1. Chart depicting the graded approach for security in the decommissioning rulemaking.

	LEVEL 1 Permanent cessation of operations and permanent removal of all fuel from the reactor vessel	**LEVEL 2** Level 1 occurred and 10 months (BWR) or 16 months (PWR) have elapsed since permanent cessation of operations	**LEVEL 3** All fuel in dry cask storage	**LEVEL 4** All fuel offsite
Physical Security	Allow certain physical security feature changes without prior NRC approval (e.g., removal of control room as a vital area)	Protection maintained for the storage of SNF before dry storage.	Allow transition from power reactor physical protection requirements to security designed for the dry storage of fuel.	
Cybersecurity	Cybersecurity requirements still apply for licensees	Removal of cybersecurity requirements	Cybersecurity requirements have been removed.	Cybersecurity requirements have been removed.

4.1 Physical security

The prevention of significant core damage and spent fuel sabotage is a general performance objective of the reactor licensee physical protection program required for operating power reactors. During the first level of decommissioning, when the NRC has acknowledged a licensee's certifications that the reactor has permanently ceased operating and all fuel has been removed from the reactor vessel and placed in the SFP, there is no longer fuel in the core and therefore the risk to public health and safety from significant core damage has been removed. Accordingly, the NRC is proposing that a licensee of a decommissioning nuclear power reactor no longer be required to protect against significant core damage.

Upon the cessation of operations and removal of all fuel from the reactor vessel, licensees typically seek to modify their security plans to reflect changes in site conditions. The NRC's regulations allow licensees to make changes to their security plans under certain conditions. Specifically, licensees may make changes to their security plans without prior NRC approval provided that the changes do not decrease the safeguards effectiveness of the plan. Licensees are required to seek NRC review and approval of any changes that result in a decrease in safeguards effectiveness of their security plans.

However, the current regulations do not define the term "decrease in safeguards effectiveness," nor do they include examples of the types of changes that would constitute a decrease in safeguards effectiveness. Additionally, there is no definition of the term "change." This lack of clarity has resulted in difficulties for licensees implementing security plan changes. For example, some licensees have implemented changes without NRC approval that later were determined by the NRC to have decreased the safeguards effectiveness of their security plan. Conversely, some licensees have unnecessarily requested NRC review and approval before certain physical protection program changes were implemented that did not decrease the safeguards effectiveness of their security plan.

To address this challenge, the NRC is proposing to amend its regulations by including definitions of the terms "change" and "decrease in safeguards effectiveness." The application of these definitions would apply to all licensees with operating, decommissioning, and/or decommissioned reactor units. The term "change" would be defined as an action that results in a modification of, addition to, or removal from, the licensee's security plans.

The term "decrease in safeguards effectiveness" would be defined as a change or series of changes to an element or component of the security plans that reduces or eliminates the licensee's ability to meet the performance objectives and capabilities of the applicable physical protection program or system required by regulation.

A vital area (VA) is defined as any area that contains vital equipment. Vital equipment is any equipment, system, device, or material, the failure, destruction, or release of which could directly or indirectly endanger public health and safety by exposure to radiation.

The NRC also considers as “vital” the equipment or systems that would be required to function to protect public health and safety following such a failure, destruction, or release.

There are specific physical security requirements for the protection of VAs and vital equipment, including that the reactor control room be considered a VA. The role of the reactor control room at an operating plant is to provide a protected space from which actions can be taken to operate the nuclear power plant safely without interruption under normal or accident conditions. For a permanently shutdown and defueled nuclear power reactor, the vital equipment associated with operating the reactor vessel is no longer needed. The remaining vital equipment (i.e., that associated with SFP cooling) may no longer be needed or may be relocated to a VA separate from the reactor control room. Once a reactor has permanently ceased operations, the need for a reactor control room is eliminated if all of the vital equipment is removed and if the area does not serve as the VA boundary for other VAs. The proposed rule would revise requirements to provide that a licensee of a decommissioning nuclear power reactor would no longer need to designate the reactor control room as a VA if it does not otherwise meet the definition for a VA.

Currently, NRC regulations require continuous and redundant communications between the reactor control room and the central alarm station (CAS) for security. Once a nuclear power reactor has permanently ceased operations, a licensee may no longer have a reactor control room, or a licensed senior operator present in a reactor control room. Therefore, it would not be feasible for a licensee of a decommissioning nuclear power reactor to comply with the current regulatory requirement. Licensees typically request an exemption from this requirement and request that the CAS instead be allowed to establish continuous and redundant communications with the senior on-site licensee representative.

The proposed rule would amend the regulations to require continuous and redundant communications between the CAS and the certified fuel handler (CFH) or the senior on-shift licensee representative once the reactor has ceased operations and the licensee no longer has licensed senior operators in the control room. The intent of this change is to allow licensees flexibility in maintaining communications with one or both of these individuals. The proposed rule would continue the following communication requirements: Continuous communication capability with onsite and offsite resources; radio or microwave transmitted two-way voice communication, in addition to conventional telephone service, between the alarm stations and local law enforcement authorities; and alternative communication measures in place in areas where communication could be interrupted or cannot be maintained.

Current regulations allow for the suspension of security measures in an emergency or during severe weather. A senior licensed operator must approve the suspension of security measures. Once a nuclear power reactor has entered decommissioning status and all fuel has been removed from the reactor, there may no longer be a licensed senior operator on site. Therefore, it may not be feasible for a licensee of a decommissioning nuclear power reactor to implement this requirement in the event of an emergency or severe weather. The proposed rule would amend the regulations to allow a CFH or other senior site representatives to suspend security measures in the event of an emergency or severe weather once the reactor has shut down and all fuel has been removed from the reactor core. These proposed changes would be consistent with existing safety regulations that govern approvals for reasonable actions that a licensee may take to depart from a license condition or a technical specification in an emergency.

An independent spent fuel storage installation (ISFSI) located at a nuclear power reactor site is typically licensed under a general license for the storage of SNF. Under a general license, licensees are required to protect the SNF in the ISFSI in accordance with the physical security requirements for an operating nuclear power reactor, with additional conditions and exceptions noted in 10 CFR 72.212, “Conditions of general license issued under § 72.210.” The NRC also licenses certain ISFSIs through the use of a specific license. Licensees holding a specific license are required to protect the SNF in the ISFSI in accordance with the physical security requirements specific to stored SNF and high-level radioactive waste. Although the physical security requirements that apply to general license ISFSIs and specific license ISFSIs provide equivalent levels of protection, there are differences. For instance, general license ISFSIs co-located with an operating reactor ensure that their physical protection program objectives maintain the capability to detect, assess, interdict, and neutralize threats. Conversely, specific license ISFSI’s physical protection objectives are to detect, assess threats, and communicate with an appropriate response organization. The NRC is proposing that once all SNF has been placed in dry cask storage, licensees may elect to protect their facilities consistent with physical requirements for specific license ISFSIs.

4.2 Cybersecurity

The NRC is updating its cybersecurity regulations for nuclear power reactor licensees to clarify the requirements applicable to a nuclear power reactor during each stage of the decommissioning process. Currently, applicants and licensees must provide high assurance that their digital computer and communication systems and networks associated with safety and important-to-safety, security, and emergency preparedness functions are adequately protected against cyberattacks, up to and including the design-basis threat described in 10 CFR 73.1, "Purpose and scope." To accomplish this, each holder of a nuclear power reactor operating license under 10 CFR Part 50 has submitted a cybersecurity plan (CSP) that has been reviewed and approved by the NRC. Each approved CSP is referenced in a license condition, which requires a licensee to maintain its CSP until the license is terminated or the license condition is removed by license amendment. However, the holder of a combined license (COL) issued pursuant to 10 CFR Part 52 does not have an equivalent cybersecurity license condition.

The NRC's cybersecurity regulations apply to licensees currently licensed to operate a nuclear power plant. Once the NRC has received certifications for permanent cessation of operations and for the permanent removal of fuel from the reactor vessel, the licensee is no longer authorized to operate a nuclear power plant, and therefore, the cybersecurity regulations would no longer apply to such a licensee. However, as discussed above, each 10 CFR Part 50 licensee has a license condition requiring the licensee to maintain its CSP, notwithstanding the cybersecurity regulations. This license condition remains in effect during decommissioning. Conversely, a COL holder does not have a condition in its license to maintain its CSP. As such, a COL holder is not required to maintain its CSP when it begins decommissioning.

Although a licensee that has submitted its certifications is no longer operating, such a licensee may still have fuel recently removed from the reactor vessel in its SFP. If the SNF in the SFP has not sufficiently decayed, there is a risk that the SNF could heat up to clad ignition temperature, leading to a zirconium fire following a postulated drain down scenarios in a timeframe that is too short to reliably implement mitigation measures or to take other appropriate response actions.

At Level 2 there is little chance that the SNF in the SFP could heat up to clad ignition temperature within 10 hours. Accordingly, the NRC proposed rule would have the cybersecurity requirements continue to apply to licensees through Level 1 but remove these requirements in Level 2 and beyond. This continuation of the cybersecurity requirements in Level 1 ensures that a compromise of digital systems cannot adversely impact the effective operation of a licensee's physical security programs and emergency functions prior to the time at which the SNF cannot reasonably heat up to clad ignition temperature within 10 hours after a drain down event. Although the cybersecurity requirements would continue to apply through Level 1, the number of critical digital assets would decrease as systems are removed from service, which in turn would reduce the number of critical digital assets that must be protected by the CSP.

To clarify the applicability of the cybersecurity requirements to decommissioning nuclear power reactor licensees, the proposed rule would add provisions that the requirements of the cybersecurity regulations would remain in effect until: (1) the NRC has docketed the licensee's certifications, and (2) at least 10 months for a BWR or 16 months for a PWR have elapsed since the date of permanent cessation of operations, or an NRC-approved alternative to the 10- or 16-month SNF decay period has elapsed. The proposed rule would also add an associated provision that, after both of the above requirements have been met, the licensee's license condition that requires implementation and maintenance of a cybersecurity plan would be deemed removed from the license.

The proposed rule would also clarify the applicability of the cybersecurity regulation, and remove unnecessary language concerning the initial submission of cybersecurity plans by existing licensees.

4.3. Drug and alcohol testing

As discussed in the previous sections, the hazards and potential consequences associated with decommissioning facilities significantly decrease in comparison to those associated with operating facilities. During decommissioning, the SFP becomes the primary focus of the licensee's strategy to protect against the design-basis threat of radiological sabotage, as the SFP becomes the location where all SNF resides prior to being transitioned to an ISFSI.

In addition to physical security and cybersecurity requirements, the proposed rule would establish a graded approach to the applicability of fitness for duty (FFD) program requirements to personnel working at a decommissioning nuclear power reactor site. This approach is based on site access, job function, and commensurate risk. Specifically, with the exception of fatigue management requirements, the same FFD program that applies to individuals working at an operating nuclear power reactor site would apply to individuals with unescorted access to a VA at a decommissioning site (i.e., the SFP), certified fuel handlers, security personnel, and FFD program personnel. However, individuals with unescorted access to only the site's protected area and not to a VA would be subject to a limited FFD program that includes specified program elements, such as pre-access drug and alcohol testing.

With this perspective, the proposed rule tailors applicability of the FFD program to the duties and access of personnel, establishing a more graded and risk-informed approach than is in place under the current regulatory framework.

5. CONCLUSION

Decommissioning nuclear power reactor licensees and the NRC have expended substantial resources preparing and processing licensing actions for nuclear power reactors during their transition period to decommissioning status. Licensees that are currently transitioning to decommissioning have been requesting NRC review and approval of licensing actions, which are informed by the low risk of an offsite radiological release posed by a decommissioning reactor. Specifically, licensees have sought NRC approval of exemptions and license amendments to revise requirements to reflect the reduced operations and risks posed by a permanently shutdown and defueled reactor. The NRC's rulemaking initiative would reduce the number of licensing actions for production and utilization facility licensees transitioning to decommissioning by establishing a graded approach to the requirements imposed on these facilities. The graded approach would adjust the level of analysis, documentation, and actions necessary to comply with security requirements based on the stage of the decommissioning process. The NRC expects that the changes in this rule will enhance the efficiency, openness, and clarity in the decommissioning process.

REFERENCES

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