

Reducing Uncertainty In The Regulatory Process For Security Of Advanced Reactors

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Abstract

As applicants and vendors begin to bring to fruition their concepts for advanced reactors, the regulatory uncertainty poses significant challenges. The regulatory efforts associated with advanced reactor security got underway in 2009, following the publication of nuclear power plant security rulemaking that emanated from the events of September 11, 2001. The NRC has begun to move in earnest in the last couple of years to better address the security for advanced reactors. Although there are two rulemaking activities that may reduce some of the uncertainty, final rules from the rulemaking process may not be published for several years. This leaves much uncertainty and confusion for the introduction of advanced reactors to enhance the electrical generation capacity of the United States. This paper provides a historical summary and insights into how vendors, and applicants can reduce the uncertainty and begin the introduction of this new technology.

Background

Advanced reactors appear to be on the verge of widescale implementation. They provide engineered safety and security features that will make them inherently safer than large light water reactors. Vendors, as well as utilities that are considering them, hope that these engineered features will lead to a reduction in the security footprint at the reactors. This will be critical to the success of their entry into the world of power generation. Security is one of the largest recurring costs at nuclear power plants today. Many older reactors with lower levels of power generation have had to cease operations, as they could not generate positive revenue for the utilities.

But as applicants and vendors begin to bring to fruition their concepts for advanced reactors, the regulatory uncertainty poses significant challenges. The regulatory efforts associated with advanced reactor security got underway in 2009, following the publication of nuclear power plant security rulemaking that emanated from the events of September 11, 2001. The NRC has begun to move in earnest in the last couple of years to better address the security for advanced reactors. Although there are two rulemaking activities that may reduce some of the uncertainty, final rules from the rulemaking process may not be published for several years. This leaves much uncertainty and confusion for the introduction of advanced reactors to enhance the electrical generation capacity of the United States.

NEI white paper

In December 2016, the Nuclear Energy Institute (NEI) published a white paper that proposed an alternative approach for the security of advanced reactors and small modular reactors (SMRs) that are unlikely to be able to have a radiological release from a sabotage event that would meet the definition of radiological sabotage under NRC regulations. The paper proposed that if the reactor met any one of three conditions, that an alternate security approach would be warranted:

1. The reactor technology precludes the ability to achieve significant core damage or radiological sabotage of spent fuel.
2. The reactor does not have an achievable target set.
3. The reactor has significant engineered safety and security features that support mitigation strategies to prevent significant core damage and radiological sabotage if a target set is defeated by the adversary.

Over the next couple of years, the NRC staff reviewed the white paper and conducted a number of public meetings in an attempt to better understand the recommendations made by NEI and consider how to respond to the paper. The staff prepared a notation vote paper identifying potential alternatives to address the security of advanced reactors in the regulatory process. The Commission directed the staff to conduct an expedited rulemaking to develop modified requirements for the security of advanced reactors. The primary changes would include a relaxation of the requirement for a specified number of armed responders and the ability to locate the secondary alarm station away from the reactor site.

NRC Rulemaking

In response to Commission direction, the staff began the expedited rulemaking for advanced reactor security. It would apply primarily to advanced reactors and SMRs. The rulemaking is focusing on reductions in the requirements for armed responders, with the potential for no onsite armed responders, and the ability to locate the secondary alarm station away from the reactor site. Much of the recent activity on the rulemaking has been in the formal development of the three conditions that would permit relief from these requirements as specified in current regulations.

A second, much larger rulemaking was also initiated. This rulemaking is known as the Part 53 Rulemaking that will address the licensing of advanced reactors and SMRs. It will include some revisions to Part 73 security requirements for these reactors as well. However, the focus of this paper is on the expedited rulemaking.

The NRC staff hosted a public meeting on August 17, 2021, titled "Rulemaking: Alternative Physical Security Requirements for Advanced Reactors." At the meeting, the NRC staff presented their thinking on the three conditions and the terminology of regulatory requirements that help to define them.

At this public meeting, the staff identified that reactors meeting any of the following three criteria warrant relaxation in security requirements:

- A. The bounding safety analysis assesses that no significant offsite release can be achieved and that the DBT cannot enhance the release above reference values,
- B. The DBT adversary cannot defeat a target set, or
- C. Regardless of damage caused by the DBT adversary, mitigation and recovery measures will prevent an offsite release.

For criterion A, only the reactor design features can be considered in the prevention of a release. Operator actions, mitigation, and the security program cannot be considered. For Criterion B, creditable operator actions and passive security features can be considered. Mitigation and recovery measures cannot be considered. Security response and active security measures cannot be considered. For Criterion C, all of the above creditable and non-creditable actions identified above are creditable.

If any of these criteria are met, relief from the current requirements will be permitted and identified by alternative requirements in the regulations. Additional relief will be identified in the Part 53 Rulemaking.

It is important to remember that the three criteria relate to both the reactor and spent fuel. It is possible that the reactor may meet one of the criteria, but the spent fuel may not. As such, the design of the facility may need to be modified to allow for more passive or active features to be present to preclude significant release from the spent fuel. For example, spent fuel might be stored below ground and may be protected by large concrete blocks.

If the facility plans to rely on local law enforcement agencies (LLEA) for armed response; it will be important to have sufficient delay built into the security program to have high assurance that the LLEA response will arrive in time to prevent a significant release.

Protection of Fresh Fuel

The security programs at advanced reactors must also consider the presence of fresh fuel that may be a target for theft. If the fresh fuel is fabricated from high assay low enriched uranium (HALEU), it will need to be appropriately protected. In particular, if the fresh HALEU fuel contains greater than or equal to 10 kg of U-235, it must be protected at the Category II level. As such, the inventory of fresh fuel should be maintained below a Category II quantity unless it is necessary to support operations. Serious consideration should be given to locate the fresh HALEU fuel in areas of the site that have protection in place for the prevention of radiological sabotage. This will allow for more efficient expenditures for overall plant protection. It should be noted that security expectations for fresh HALEU fuel may differ from what is found in the regulations, as 10 CFR73.67 was published in 1979 and approaches to security have changed significantly since then. The NRC staff uses the technical approach from a rulemaking that was stopped in 2018 to make case-by-case decisions on security of this material.

In the Interim

Until the new regulations are published, it will be necessary for advanced reactor and SMR applicants to be creative in both the design of their security programs, as well as the security plans that support their license applications. They will need to focus on the performance metrics that can be implied by prescriptive requirements in the regulations and design their programs to meet those metrics. They will need to use exemptions and alternate approaches to identify how the design differs from existing requirements, while at the same time demonstrate that it meets the intent of NRC regulations.

Summary

The advent of advanced reactors and SMRs has resulted in many new initiatives in the industry and at the NRC to help them become a reality. Until the new regulations are in place, there will be significant uncertainty within the industry and the NRC on how to develop applications and how to review them. It will be important to be creative and open-minded to allow this new generation of reactors to become a reality.