Draft White Paper on Potential Changes to Physical Security Requirements for Small Modular and Advanced Reactors
November 2017 Draft – Released to Support Public Discussions

A contributing activity within the U.S. Nuclear Regulatory Commission's (NRC's) implementation action plan for improving its regulatory readiness for non-light water reactor (non-LWR) designs includes identifying and resolving policy issues (Strategy 5). An issue identified during interactions with stakeholders is establishing the appropriate security requirements for advanced reactor designs. This draft white paper has been prepared and is being released to support ongoing public discussions. This draft paper has not been subject to NRC management and legal reviews and approvals, and its contents should not be interpreted as official agency positions. Following the public discussions (including a public meeting scheduled for December 13, 2017), the staff plans to continue working on this paper as well as other activities defined in the agency's vision and strategies document. This white paper and related interactions with stakeholders will be considered in a paper the staff plans to provide to the Commission in early 2018.

SUMMARY:

This white paper and related interactions with stakeholders will be considered in a paper the staff plans to provide to the Commission in early 2018. The need for physical security is based upon the potential ability of would-be adversaries to cause a release of radioactive materials by acts of radiological sabotage or removing special nuclear material from the facility by theft or diversion. The current physical security framework for large light water reactors (LWRs) is designed to address the possibility of an adversary force disabling particular target sets of structures, systems, and components resulting in a loss of safety functions leading to damage of a reactor core or spent fuel and a release of radioactive materials. The designs and behavior of small modular reactors (SMRs) and non-LWRs can be significantly different from large LWRs and may warrant different physical security requirements.

BACKGROUND:

The existing physical security requirements and related NRC reviews and inspections have been developed to ensure that the physical protection equipment and programs put in place by licensees for commercial power reactors provide high assurance of protection against a design-basis threat (DBT). The DBT describes the adversary force that the licensee must defend against. The DBT is based on realistic assessments of the tactics, techniques, and procedures used by international and domestic terrorist groups and organizations. The physical security requirements for a nuclear power licensee to protect against the DBT of radiological sabotage can be found in Section 73.55, "Requirements for physical protection of licensed activities in nuclear power reactors against radiological sabotage," in Part 73, "Physical Protection of Plants and Materials" to Title 10 of the *Code of Federal Regulations* (10 CFR 73.55). Other sections within 10 CFR Part 73 define requirements for protection of various forms of special nuclear material from theft or diversion. The DBTs used to design safeguards systems to protect against acts of radiological sabotage and to prevent the theft or diversion of special nuclear material are defined in 10 CFR 73.1, "Purpose and scope."

The NRC's regulations related to physical security for nuclear power plants and other types of facilities include performance-based and prescriptive requirements. The use of performance-based requirements provides licensees with flexibility to determine how to meet the established performance criteria in ways that encourage and reward improved outcomes. The NRC's security requirements across different classes of licensees also reflects a performance-based or graded approach. The graded approach applies the appropriate level of security for the potential radiological consequences of a sabotage-type event or the value of stolen material in constructing a weapon.

The NRC's Policy Statement on the Regulation of Advanced Reactors was first issued on July 8, 1986 (51 FR 24643) with an objective to provide all interested parties, including the public, with the Commission's views concerning the desired characteristics of advanced reactor designs. The policy statement identifies attributes that should be considered in advanced designs, including highly reliable and less complex heat removal systems, longer time constants before reaching safety system challenges, reduced potential for severe accidents and their consequences, and use of the defense-in-depth philosophy of maintaining multiple barriers against radiation release. The staff recognized the potential implications of these attributes on security requirements and had the following observation in NUREG-1226, "Development and Utilization of the NRC Policy Statement on the Regulation of Advanced Nuclear Power Plants," published in June 1988:

> It is expected that, in many cases, advanced reactors, due to their inherent safety characteristics and simplified safety systems, will be less reliant upon physical security systems and procedures for protection against sabotage than current generation plants.

The policy statement was revised in 2008 (73 FR 60612; October 14, 2008) to specifically include attributes related to physical security and theft and diversion of radioactive materials that should be considered in advanced designs, such as:

> Designs that include considerations for safety and security requirements together in the design process such that security issues (e.g., newly identified threats of terrorist attacks) can be effectively resolved through facility design and engineered security features, and formulation of mitigation measures, with reduced reliance on human actions.

In addition to defining favorable attributes for advanced reactor designs, the Commission provided the following observations on the possible implementation of the policy statement:

> Finally, the NRC also believes that it will be in the interest of the public as well as the design vendors and the prospective license applicants to address security issues early in the design stage to achieve a more robust and effective security posture for future nuclear power reactors.

The staff noted in SECY-10-0034, "Potential Policy, Licensing, and Key Technical Issues for Small Modular Nuclear Reactor Designs," dated March 28, 2010 (Agencywide Documents Access and Management System [ADAMS] Accession No. ML093290245) that establishing physical security requirements and guidance for SMRs and non-LWRs was a key policy issue of high importance. The staff recognized that physical security requirements, particularly concerning the appropriate number of security staff and size of the protected area, is an important factor for reducing regulatory uncertainty for advanced reactor developers. Also, industry has indicated that the physical security requirements will be a key factor in the business case for advanced reactor feasibility and development. The NRC staff reiterated the need to resolve policy issues within the document "NRC Vision and Strategy: Safety Achiveing Effective and Efficient Non-Light Water Reactor Mission Readiness," issued in December 2016 (ADAMS Accession No. ML16356A670) and the related NRC Non-Light Water Near-Term Implementatoin Action Plans issued in July 2017 (ADAMS Accession No. ML17165A069).

The staff reported to the Commssion in SECY-11-0184, "Security Regulatory Framework for Certifying, Approving, and Licensing Small Modular Nuclear Reactors," dated December 29, 2011 (ADAMS Accession No. ML112991113) that the current security regulatory framework is adequate for SMRs and non-LWRs, including related elements of the nuclear fuel cycle.[1] The staff observed in SECY-11-0184 that current regulations allow SMR designers and potential applicants to propose alternative methods or approaches to meet the performance-based and prescriptive security and material control and accounting requirements. These alternative methods or approaches may include increased reliance on engineered systems or reduced reliance on operational requirements and staffing, to meet the intent of the regulatory requirements. The question at hand is whether some type of generic regulatory action would be preferable to the case-by-case approach described in SECY-11-0184.

The NRC published a notice and request for public comment in the *Federal Register* on preliminary draft guidance on non-light water reactor security design considerations (March 13, 2017, 82 FR 13511). The staff developed the draft criteria in parallel with activities related to developing advanced reactor design criteria to reflect the inclusion of security matters in the Advanced Reactor Policy Statement. Activities related to the security design considerations were suspended in order to focus on assessments of potential changes to regulatory requirements. Initial interactions related to a possible rulemaking involved meetings on the Nuclear Energy Institute (NEI) white paper "Proposed Physical Security Requirements for Advanced Reactor Technologies" (ADAMS Accession No. ML17026A474). The white paper suggested high level criteria for determining when an advanced reactor design would be a candidate for alternative security requirements. The paper includes the following observation regarding the perceived need to revise NRC regulations related to physical security for advanced reactors:

> The rule changes proposed herein would promote the establishment of a clear, predictable and stable licensing process for advanced reactor technologies, and avoid the inefficiency and uncertainty associated with achieving compliance through alternative measures, exemptions and license conditions. Absent a

[1] The focus of this paper is on the physical security requirements for an advanced nuclear power plant. Other activities within the industry and the NRC are also addressing possible policy and technical issues, including security requirements, for other parts of the fuel cycle. Many non-LWR designs are expected to use higher assay low enriched uranium (HALEU; between 5 and 20 percent enrichments) and fuel forms other than the traditional uranium dioxide pellets used for light water reactors. The different fuel forms also introduce the possible need to develop new approaches to material control and accounting (MC&A) practices. These and other issues related to HALEU and the nuclear fuel cycle will be the subject of future interactions between the staff and stakeholders.

> change to existing regulations, advanced reactor technologies will be subject to the existing physical security requirements delineated in § 73.55, which would impose an unnecessary regulatory burden on applicants and licensees. Compliance with § 73.55 requirements will diminish the cost competitiveness of advanced reactor technologies, thus hindering their development and deployment.

Similar arguments of reducing regulatory uncertainties were made by stakeholders and the NRC staff in SECY-15-0077, "Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies" (ADAMS Accession No. ML15037A176) regarding assessments of the NRC requirements related to offsite emergency planning zones. In the staff requirements memorandum (SRM) for SECY-15-0077, dated August 4, 2015 (ADAMS Accession No. ML15216A492) the Commission provided the following direction to the NRC staff:

> The Commission has approved the staff's recommendation to initiate a rulemaking to revise regulations and guidance for emergency preparedness (EP) for small modular reactors (SMRs) and other new technologies, such as non-light-water reactors (non-LWRs) and medical isotope production facilities.
>
> The staff should keep the Commission's previous direction from the Staff Requirements Memorandum (SRM) for SECY-14-0038, "Performance-Based Framework for Nuclear Power Plant Emergency Preparedness Oversight," in mind. That SRM stated "The staff should be vigilant in continuing to assess the NRC's emergency preparedness program and should not rule out the possibility of moving to a performance-based framework in the future. The Commission notes the potential benefit of a performance-based emergency preparedness regimen for small modular reactors." This rulemaking provides an opportunity for the staff to further explore the pros and cons of a performance-based EP framework.

The NRC staff subsequently provided the Commission SECY-16-0069, "Rulemaking Plan on Emergency Preparedness for Small Modular Reactors and Other New Technologies," dated May 31, 2016 (ADAMS Accession No. ML160202A388). The Commission approved the rulemaking plan in its SRM dated June 22, 2016 (ADAMS Accession No. ML16174A166).

DISCUSSION:

In an SRM following a March 29, 2011, Commission briefing on SMRs (ADAMS Accession No. ML110880535), the Commission directed the staff to, "…think expansively about upcoming issues and to engage the Commission early if they are uncertain whether an issue is a matter of policy. Early engagement will allow the Commission to help staff narrow a range of options, if necessary, and prevent subsequent redirection." Therefore, staff is using this paper to explore whether the staff should proceed with a rulemaking action to further assess and, if appropriate, pursue revising NRC regulations related to physical security requirements for advanced reactors.

***Option 1***:

Option 1 is to maintain the status quo with no changes to the current physical security regulations and no staff efforts to develop guidance to support requests for proposed alternatives or exemptions. Applicants for licenses could propose alternatives in accordance with 10 CFR 73.55(r), "Alternative measures," or request exemptions from NRC regulations using provisions such as 10 CFR 73.5, "Specific exemptions." The NRC is not yet reviewing license applicatons for SMRs or non-LWRs and so do not have a specific example of a proposed alternative or exemption. However, based on stakeholder interactions related to the NEI white paper, the staff anticipates that applications would include proposed alternatives and exemptions to the prescribed miniumum number of armed responders[2] currently defined in 10 CFR 73.55(k), "Response Requirements." The NRC staff would review and decide upon such proposed alternatives or exemption requests as part of each application.

*Advantages:* Agency resources will not be spent on rulemaking and the related guidance documents. Applications for proposed alternatives or exemptions will be considered using existing guidance and procedures.

*Disadvantages:* This option does not reduce the regulatory uncertainties identified by the staff and some stakeholders regarding policy matters addressed on a case-by-case basis. These uncertainties complicate the ability of reactor developers and potential licensees to make design and business decisions. Case-by-case decisionmaking may not support the goals described in the Principles of Good Regulation, the Policy Statement on the Regulation of Advanced Reactors and more recent documents defining vision and strategies and implementation action plans for non-LWR regulatory readiness.

*Stakeholder Views ?*

***Option 2*:**

Option 2 does not involve changes to NRC regulations but the NRC staff would prepare guidance for processing requests for proposed alternatives or exemptions related to physical security requirements for SMRs and non-LWRs. Advanced reactor developers or other parties could prepare generic performance requirements, acceptance criteria, and associated technical bases (e.g., topical reports), or applicants for licenses could propose alternatives in accordance with 10 CFR 73.55(r) or request exemptions from NRC regulations using provisions such as 10 CFR 73.5. Such submittals and the related NRC reviews would be supported by guidance issued by the NRC staff.

*Advantages:* Agency resources will not be spent on rulemaking. Applications for proposed alternatives or exemptions will be considered using existing procedures and the newly issued guidance documents. The guidance documents and possible review of generic submittals for a design or class of designs would reduce regulatory uncertainties. The NRC process for preparing and issuing guidance documents includes the opportunity for public engagement on the issues related to physical security for advanced reactors.

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2 *10 CFR 73.2, Definitions10 CFR 73.2, states "Armed response personnel* means persons, not necessarily uniformed, whose primary duty in the event of attempted theft of special nuclear material or radiological sabotage shall be to respond, armed and equipped, to prevent or delay such actions."

*Disadvantages:* This option only partially addresses the regulatory uncertainties identified by the staff and some stakeholders. This option would require resources to prepare guidance but not provide the same degree of certainty or finality of agency decisions that are provided by a rulemaking. The NRC has traditionally attempted to avoid regulating by exemption when an issue can be addressed through a generic action such as rulemaking. Foregoing a rulemaking would ultimately still require case-by-case decisionmaking, which raises concerns about consistency, clarity and predictability of NRC's regulatory process.

*Stakeholder Views ?*

***Option 3:***

Option 3 is to revise specific regulations and guidance related to physical security for SMRs and non-LWRs through rulemaking. The NRC staff would interact with stakeholders to identify specific requirements within existing regulations that contribute significantly to capital or operating costs but may play a diminished role in providing physical security for SMRs and non-LWRs. A possible example of this option is described in the NEI white paper, which suggested an assessment and associated criteria for an alternative to the prescribed miniumum number of armed responders currently defined in 10 CFR 73.55(k), "Response requirements."[3] The staff estimates the current requirement adds approximately 5 million dollars per year to the operating costs of a nuclear power plant. Design attributes of SMRs and non-LWRs may justify less reliance on human actions such as those provided by armed responders during attempts to steal special nuclear material or sabotage a plant.

The staff believes it is reasonable to consider incorporating alternatives for some physical security requirements into NRC's regulations to address advanced reactor designs and their associated design features (e.g., smaller cores or passive safety systems). The attributes of advanced reactor designs are expected to include smaller and slower releases of fission products following a loss of safety functions due to malfunctions or malicious acts. The staff anticipates that the specific requirements and alternatives in a "limited scope" rulemaking would result from assessments and interactions with stakeholders during the rulemaking process. In addition to the rulemaking to provide SMR and non-LWR alternatives to identified requirements within the current regulations, the staff would develop guidance for applicants. The level of effort to prepare guidance supporting the rulemaking is expected to be comparable to that needed for Option 2. A rulemaking plan for this limited scope option is provided as an enclosure to this paper and would be used by the staff if approved by the Commission.

*Advantages:* Changes to a limited scope of requirements related to physical security for SMRs and non-LWRs would: (1) promote regulatory stability, predictability, and clarity; (2) eliminate the need for future applicants to propose alternatives or request exemptions from physical security requirements; and (3) recognize technology advancements and design features associated with the NRC recommended attributes of advanced reactors. The rulemaking

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[3] The NEI white paper includes performance-based criteria for determining the applicability of alternative security requirements for a specific design or facility A criterion suggested in the white paper involves delayed radiological consequences such that offsite resources could address the security event and the potential loss of safety functions resulting from the DBT. The NEI white paper notes that this criterion is related to an ongoing staff activity assessing physical security requirements for operating reactors, and in particular the potential role of crediting local, State, or Federal law enforcement response to establish coping times (see SRMSECY-16-0073, "Options and Recommendations for the Force-on-Force Inspection Program in Response to SRM-SECY-14-0088," dated October 5, 2016 and SECY-17-0100, "Security Baseline Inspection Program Assessment Results and Recommendations for Program Efficiencies," dated October 4, 2017)

process includes the opportunity for public engagement on the issues related to physical security for advanced reactors. Public notice and comment during rulemaking would provide the widest range of viewpoints for Commission consideration in the development of the proposed rule.

*Disadvantages:* This option requires rulemaking and creation of new guidance for the revised physical security requirements for SMRs and non-LWRs, which would require resource expenditures.

*Stakeholder Views ?*

***Option 4***:

Option 4 involves a broad scope rulemaking to assess and define physical security requirments for advanced reactor designs. The variety of advanced reactor designs would likely require a performance-based approach with physical security requirements defined in terms of different design features, including inherent design characteristics. This option might also include threat assessments to determine if different DBTs may be warranted for advanced reactors. The NRC would need to interact with stakeholders and consult with experts on both security and advanced reactors to define relationships and possible performance-based requirements. While theoretically this option would best integrate security considerations into the reactor design process, the level of effort for Option 4 would be significant and it is doubtful such an activity would be completed in time to help current reactor developers make critical design decisions. The staff has not developed a rulemaking plan for this option but the level of effort for this activity would likely be comparable to major rulemakings such as those undertaken following the terrorist attacks in 2001 or the Fukushima accident in 2011.

*Advantages:* In a world free from resource constraints or schedules, this option would best integrate performace-based security requirements into the processes for developing advanced reactor plant designs.

*Disadvantages:* This option would require significant resources and would be unlikely to support current reactor developers needing to make critical design decisions.

*Stakeholder Views ?*

Enclosure:
Rulemaking Plan

Title

Alternate Physcial Security Requirements for Small Modular Reactors and Non-Light Water Reactors

Estimated Schedule

Initiate regulatory basis phase –
Complete regulatory basis –
Publish proposed rule –
Publish final rule –

Preliminary Priority

The staff estimated that this activity would be a medium priority rulemaking using the Common Prioritization of Rulemaking prioritization methodology. This rulemaking is estimated as a medium priority because: a) it would be a moderate contributor toward the NRC Strategic Plan safety and security goals and implement several of the Plan's safety strategies; b) it would be a moderate contributor toward the Strategic Plan's Regulatory Effectiveness strategies; c) it would significantly support an NRC licensing initiative with a future regulatory benefit, considering Commission and Congressional interest in SMRs and non-LWRs; and d) there is substantial public interest on this topic. There is additional, relevant information supporting this preliminary priority in the "Relationship of the Work to the NRC's Strategic Plan" section of this enclosure.

Description and Scope

The major objective of revising 10 CFR 73, "Physical protection of plants and materials," and associated regulations is to enhance regulatory effectiveness by providing a stable and predictable process for implementing physical security for SMRs and non-LWRs. The revision will consider technological advancements in reactor designs and their associated design features impacting the possible loss of safety functions from malicious acts and the resultant consequences. The rulemaking would permit future applicants and licensees to demonstrate their safety case and technical basis to meet alternative requirements for a risk-informed, performance-based approach for designated portions of the physical security program.

The benefits of changing the regulations for physical security for SMRs and non-LWRs include the following: a) reduction in the number of exemption requests as compared to current regulations; b) reduction in the number of security staff or other security features compared to those currently required by 10 CFR 73.55, but reflective of offsite consequences and radiation risks to public health and safety; c) consistency in regulatory applicability in the review of physical security plans in accordance to 10 CFR Part 73; and d) potential use of a more risk-informed, performance-based physical security framework.

Relationship of the Work to the U.S. Nuclear Regulatory Commission's Strategic Plan

The NRC staff expects that the rulemaking will have no negative impact on the safety goal of the NRC's Strategic Plan. The most significant impact of the intended rulemaking to revise 10 CFR Part 73 would be the enhancement of regulatory effectiveness by providing a stable and predictable process for implementing new physical security requirements for SMRs and non-LWRs. This approach supports the principles of good regulation, including openness, clarity, and reliability.

The staff notes that a rulemaking effort, "Emergency Preparedness for Small Modular Reactors and Other New Technologies," is currently ongoing, as directed by the Commission in SRM-SECY-16-0069, "Rulemaking Plan on Emergency Preparedness for Small Modular Reactors and Other New Technologies," (ADAMS Accession No. ML16174A166). The scope of the ongoing rulemaking is limited to emergency preparedness for advanced reactors but much of the rational for pursuing the rulemaking and the technical justifications for recognizing the attributes of advanced reactor designs is similar to the current discussions related to possible alternatives to physical security requirements.

Substantial public interest is expected on this rulemaking because of the potential to reduce physical security requirements for SMRs and non-LWRs. The staff intends to hold public meetings in concert with the publication of the proposed rule and revisions of guidance, as appropriate. The meetings will enable staff to engage stakeholders, receive feedback, and answer questions regarding the proposed rule and guidance. In addition to publication in the Federal Register, the rulemaking and any proposed revision of guidance documents will also be placed on the NRC's web site to enhance public dialogue.

Cost and Benefits

The proposed action is estimated to involve a medium magnitude of costs, largely due to developing a regulatory basis for and guidance supporting the methodology for possible alternatives for physical security for advanced reactor designs. The proposed action is estimated to provide the following benefits: a) reduction in the number of exemption requests as compared to current regulations; b) reduction in the number of security staff or other security features compared to those currently required by 10 CFR 73.55, but reflective of offsite consequences and radiation risks to public health and safety; c) consistency in regulatory applicability in the review of physical security plans in accordance to 10 CFR Part 73; and d) potential use of a more risk-informed, performance-based physical security framework.

Cumulative Effects of Regulation

This rulemaking would have a net positive impact on cumulative effects of regulation because: a) it would potentially reduce regulatory burden for applicants for SMRs and non-LWRs, b) it is currently anticipated that there are no critical skill sets or other ongoing NRC activities that would significantly impact the implementation of the proposed change, and c) the staff plans to hold public meetings at several key steps in the process and provide an extended public comment period.

Agreement State Considerations

Backfitting and Issue Finality

Guidance

The staff estimates that one or more new guidance document(s) will be developed in parallel with the rulemaking. Current guidance for operating reactors would likely remain unchanged.

Advisory Committee on Reactor Safeguards Review

Committee to Review Generic Requirements Review

Analysis of Legal Matters