POLICY ISSUE
NOTATION VOTE

RESPONSE SHEET

TO: Brooke P. Clark, Secretary

FROM: Commissioner Baran

SUBJECT: SECY-20-0045: Population Related Siting Considerations for Advanced Reactors

Approved ____ **Disapproved** X **Abstain** ____ **Not Participating** ____

COMMENTS: **Below** ____ **Attached** X **None** ____

Entered in "STARS"
Yes X
No ____

Jeffery M. Baran
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Commissioner Baran's Comments on SECY-20-0045,
"Population-Related Siting Considerations for Advanced Reactors"

It is important for NRC to establish the right regulatory framework for advanced reactors. NRC's current power reactor regulations were written for light-water reactors, which make up the entire existing fleet. It makes sense to update those requirements to address different technologies. Creating a regulatory framework for non-light-water reactors will enable the agency to perform effective and efficient licensing reviews and oversight, while providing regulatory certainty for potential applicants and vendors.

New reactor designs have the potential to be safer than existing designs. In its regulations, NRC needs to strike a reasonable balance between taking into account the value of new safety attributes and maintaining a prudent degree of defense-in-depth. Some elements of NRC's existing regulations for large light-water reactors will not be appropriate for non-light-water reactors. Other requirements reflect enduring defense-in-depth principles that should apply to advanced reactors, such as the need for appropriate emergency planning and siting. To protect the public from low-probability, high-consequence events, these defense-in-depth elements can evolve but should continue to play an important role. This is especially true for new technologies that have limited operating experience.

Multiple, independent layers of protection against potential radiological exposure are necessary because we do not have perfect knowledge of new reactor technologies and their unique potential accident scenarios. As the Advisory Committee on Reactor Safeguards explained:

> There is a tendency to believe in the perfection of new designs, especially when they are developed to eliminate the dominant failure scenarios in existing designs. However, one must remain vigilant and remember that nature provides surprises. There will be new accident scenarios and new combinations of events to be considered that challenge our expectations and our assumptions about these advanced reactor systems.[1]

Unlike light-water reactors, new advanced reactor designs do not have decades of operating experience; in many cases, the new designs have never been built or operated before. It is reasonable to expect that the agency and licensees will have much to learn about the issues, risks, and accident sequences particular to each new design. With the current fleet of light-water reactors, we learned over time that some accident scenarios were more important than initially predicted. Large-break loss-of-coolant accidents were thought to be the most severe potential design basis accidents until the small-break loss-of-coolant incident at Davis-Besse in 1977 and the accident at Three Mile Island Unit 2 in 1979. As operating experience continued to accumulate, it also became apparent that onsite and offsite electric power was less reliable than expected, and the station blackout scenario was found to be an important contributor to the overall risk of nuclear power plant accidents. A key lesson of this decades-long learning curve is that we should not remove independent layers of defense for novel technologies because we are convinced today that a new design will be safer than existing light-water reactor designs.

[1] Letter from Peter C. Riccardella, Chairman of ACRS, to Chairman Kristine Svinicki regarding "Review of Draft SECY Paper, 'Population-Related Siting Considerations for Advanced Reactors'" (Oct. 7, 2019).

Siting limitations are a crucial element of defense-in-depth for nuclear power plants. Other NRC requirements are focused on preventing or mitigating a radioactive release. Siting restrictions are there to provide another layer of defense in case a release occurs despite those safety requirements. They are in place to address low-probability, high-consequence accident scenarios. As Oak Ridge National Laboratory explains:

> Time, distance, and shielding constitute the societal safety triad for radionuclides…. Of the time, distance, and shielding protective elements, distance is the element that can consistently be structured for public safety through regulations and guidance. Time and shielding are dependent on individual designs.[2]

For this reason, NRC "has a longstanding policy of siting nuclear reactors away from densely populated centers and preferring areas of low population density."[3] In fact, limitations on where reactors can be sited have been used to protect the public for decades, pre-dating NRC itself. When the Part 100 siting regulations were first issued in 1962, the Atomic Energy Commission noted that:

> since accidents of greater potential hazard than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to provide for protection against excessive exposure doses to people in large centers, where effective protective measures might not be feasible … Hence, the population center distance was added as a site requirement.[4]

In 1973, the Atomic Energy Commission reiterated its view that siting restrictions would help protect the public from unexpected accidents, stating:

> There has been no reason to take the additional incremental risk, however small, of incurring doses to a large metropolitan population as a result of any accident in the nuclear facility when other suitable sites, less densely populated, remain available. Also, the difficulty of instituting effective protective measures for the surrounding populace in the event of an accident increases with increased population density.[5]

Part of the rationale for siting restrictions was that "operating experience data [were] not abundant" for the light-water reactors being introduced at that time.[6]

This approach continued after NRC was created. From the start, NRC sought "to strengthen siting as a factor in defense-in-depth by establishing requirements for site approval that are independent of plant design consideration."[7] In other words, siting restrictions were seen as an important layer of defense, regardless of the safety attributes of a particular nuclear reactor design.

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[2] Oak Ridge National Laboratory, "Advanced Reactor Siting Policy Considerations" (June 2019) at 15.
[3] SECY-20-0045 at 1.
[4] *See* "Reactor Site Criteria Including Seismic and Earthquake Engineering Criteria for Nuclear Power Plants," 61 Fed. Reg. 65157 at 65162 (Dec. 11, 1996).
[5] *See* Oak Ridge at 12.
[6] *Id.*
[7] *See id.* at 24.

In 1980, Congress mandated this approach by directing NRC to promulgate nuclear power plant siting regulations that "shall specify demographic criteria for facility siting, including maximum population density and population distribution for zones surrounding the facility without regard to any design, engineering, or other differences among such facilities."[8] The Part 100 siting regulations were ultimately revised in 1996, and this is the version of the regulation that remains in effect today.

The relevant portion of the regulation provides:

> Reactor sites should be located away from very densely populated centers. Areas of low population density are, generally, preferred. However, in determining the acceptability of a particular site located away from a very densely populated center but not in an area of low density, consideration will be given to safety, environmental, economic, or other factors, which may result in the site being found acceptable.[9]

The "Purpose" section of the regulation states:

> The Commission intends to carry out a traditional defense-in-depth approach with regard to reactor siting to ensure public safety. Siting away from densely populated centers has been and will continue to be an important factor in evaluating applications for site approval.[10]

Thus, the siting regulation is focused on ensuring defense-in-depth, while building in some flexibility to consider site-specific factors. In the 1996 Statements of Consideration, the Commission explained that "[l]imitation of population density beyond the exclusion area has the following benefits: (a) It facilitates emergency preparedness and planning; and (b) It reduces potential doses to large numbers of people and reduces property damage in the event of severe accidents."[11]

Those principles and goals are reflected in the associated NRC staff regulatory guidance, which states that reactors should be sited at locations where the average population out to a radius of 20 miles does not exceed 500 people per square mile.[12] Like the regulation, the guidance provides flexibility, noting that "consideration of other factors, such as safety, environmental, or economic concerns, may result in the site with the higher population density being found acceptable."[13] Unlike the regulation, the guidance is not binding and merely offers one acceptable approach for an applicant to demonstrate compliance with the underlying regulatory requirements.

In 1996, the Commission explicitly considered whether the siting restrictions should apply to advanced reactors. And the Commission decided that they should. The Commissioners understood that "next-generation reactors are expected to have risk characteristics sufficiently low that the safety of the public is reasonably assured by the reactor and plant design and operation itself, resulting in very low likelihood of occurrence of a severe

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[8] NRC Authorization Act for Fiscal Year 1980, Section 108(c).
[9] § 100.21(h), 61 Fed. Reg. 65176.
[10] § 100.1(d), 61 Ref. Reg. 65175.
[11] 61 Fed. Reg. 65162.
[12] NRC, *General Site Suitability Criteria for Nuclear Power Stations*, RG 4.7, Revision 3 (Mar. 2014).
[13] *Id.*

accident."[14] They also recognized that "siting a reactor closer to a densely populated city than is current NRC practice would pose a very low risk to the populace."[15] The Commission nevertheless concluded that "defense-in-depth considerations and the additional enhancement in safety to be gained by siting reactors away from densely populated centers should be maintained." This conclusion is just as true today. It is still NRC's job to protect the public from low-probability, high-consequence radiological events.

The NRC staff's recommended Option 3 would change the guidance and interpretation of the regulation to scale back siting restrictions for advanced reactors. It would accomplish this by shrinking the land area "within which the population density would be assessed using the current criterion of density no greater than 500" people per square mile based on "estimates of radiological consequences from design-specific events."[16] Specifically, the 500-people-per-square-mile limitation would only apply "out to a distance equal to twice the distance at which a hypothetical individual could receive a calculated dose of 1 rem over a period of one month from the release of radionuclides following postulated accidents."[17] But for reactor designs deemed sufficiently safe, that could amount to no distance from the site boundary at all. In that circumstance, the siting restrictions reflected in the regulatory guidance would not provide additional protection to the public. A reactor could be sited within a town of 25,000 people and right next to a large city.[18] For reactor designs that have not been deployed before and do not have operating experience, that approach may be insufficiently protective of public health and safety. Moreover, this approach arguably would be inconsistent with the Part 100 requirement that "reactor sites should be located away from very densely populated centers." And it would not maintain the key defense-in-depth principle of having prudent siting limitations regardless of the features of a particular reactor design – a principle that has been a bedrock of nuclear safety.

In my view, we should not reduce siting protections for advanced reactor technologies at this time. Instead, NRC should initially retain the existing siting guidance (Option 1). Based on six decades of experience, this longstanding approach will provide the necessary defense-in-depth for new technologies while they gain operating experience. It is also consistent with the prudent siting restrictions the agency has established in regulation. And it provides a reasonable amount of flexibility to consider the circumstances of a specific site or project. In fact, the population density limitations suggested by the current guidance should allow for many of the sites being contemplated by advanced reactor developers, including villages, military bases, and former fossil generation sites. Of course, because the regulatory guidance is non-binding, applicants could also propose alternative siting criteria to meet the requirements of the regulation.

As advanced reactors are deployed and operating experience is gained with these designs, it may make sense for NRC to revisit the siting restrictions. But for now, it would be prudent to retain this effective tool for protecting the public.

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[14] 61 Fed. Reg. 65162.
[15] *Id.*
[16] SECY-20-0045, Enclosure at 9.
[17] *Id.*
[18] *See*, *e.g.*, *id.* at 12 ("an advanced reactor with estimated doses below 1 rem at the site boundary over the month following the assumed postulated accident could hypothetically be allowed within towns with populations of no more than approximately 25,000 residents").