July 15, 2025

U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: BTI Comments on the ADVANCE Act: Population Density Considerations

Dear U.S. Nuclear Regulatory Commission Staff:

The Breakthrough Institute (BTI) appreciates this opportunity to comment on ongoing NRC activities on population density considerations for new nuclear siting and deployment related to the implementation of the ADVANCE Act. BTI is an independent 501(c)(3) global research center that advocates for appropriate regulation and oversight of nuclear reactors to enable the new and continued use of safe and clean nuclear energy. BTI acts in the public interest and does not receive funding from industry.

As the NRC works to implement several provisions of the Accelerating Deployment of Versatile, Advanced Nuclear for Clean Energy (ADVANCE) Act, we encourage the agency to reevaluate population density and distance from population center requirements that were developed in the context of large light-water reactors (LWRs) and may not align with the safety profiles or siting opportunities of advanced reactor designs.

The continuation of distance-based population criteria, such as those found in 10 CFR Part 100 and Regulatory Guide 4.7, could unnecessarily limit the deployment of advanced nuclear technologies. Particularly in cases where robust, passive safety features and reduced source terms substantially lower the potential risk to the public. BTI has previously commented on this topic through our response to Draft Regulatory Guide DG-4034 (General Site Suitability Criteria for Nuclear Power Stations [Docket ID: NRC-2023-0153]).[1]

In that comment, BTI highlighted several ways that current population density guidance may unintentionally exclude otherwise suitable sites, including existing nuclear plant locations and

[1] Dr. Adam Stein, The Breakthrough Institute, *Comment on Draft Regulatory Guide DG-4034: General Site Suitability Criteria for Nuclear Power Stations [Docket ID: NRC-2023-0153],* October 18, 2023, ML23326A032. (Hereinafter BTI Comment on DG-4034).

retiring fossil fuel sites, while failing to account for advancements in reactor design and safety. More recently, we have been engaged in the ongoing effort by the staff to present and update the public on key findings and milestones as the ADVANCE Act is implemented.

On November 21st 2024, the staff held a public meeting on ADVANCE Act implementation related to brownfield sites.[2] We were engaged in discussion during the meeting on exemptions related to population centers, updates to Regulatory Guide (RG) 4.7, as well as siting related to population centers with a population no larger than 25,000. On March 4th, 2025, the staff held a public meeting on section 207 of the ADVANCE Act, which requires the NRC to establish and carry out an expedited procedure for qualifying combined license applications.[3] We commented on remaining questions related to site similarity in the context of fluctuating population density.

As requested by the staff, we aim to provide further details stemming from the topics discussed during those two public meetings and our engagement on this topic in the past. Building on verbal and written input, this letter urges the NRC to take additional steps to shift away from current approaches to population thresholds and toward a more risk-informed, performance-based approach; one that is consistent with both the intent and the statutory direction of the ADVANCE Act.

1. Regulatory Context

The NRC's current population density criteria is prescriptive, not sufficiently risk-informed, and inconsistent with performance-based regulatory approaches and the evolving safety profiles of advanced nuclear technologies.

The NRC's current population density criteria for nuclear power plant siting are primarily set forth in 10 CFR Part 100 and elaborated in RG 4.7 (General Site Suitability Criteria for Nuclear Power Stations). These frameworks define how population density, distribution, and land use should be considered when determining site suitability for nuclear reactors. Specifically, 10 CFR

[2] ADVANCE Act Section 206: NRC Licensing at Brownfield Sites - Information Exchange, November 21, 2024, https://www.nrc.gov/pmns/mtg?do=details&Code=20241407

[3] Combined License Review Procedure - ADVANCE Act Section 207, March 4, 2025, https://www.nrc.gov/pmns/mtg?do=details&Code=20250193

100.21(h) requires that: *"The population density, use characteristics, and distribution in the vicinity of the site must be such that appropriate protective measures can be taken in the event of a serious accident."*

Historically, to satisfy this requirement, the NRC has relied on prescriptive population thresholds and distance-based zones, established with the safety considerations of large LWRs in mind.

The Nuclear Energy Innovation and Modernization Act (NEIMA), enacted in 2019, directed the NRC to develop strategies for expanding the use of risk-informed, performance-based licensing evaluation techniques for advanced reactors.[4] Among the specific focus areas identified in the statute were licensing basis event selection, source terms, and containment performance; all fundamental components of how reactor safety and siting decisions are made. This directive reflected a growing consensus that the NRC's legacy regulatory framework, developed primarily for large light-water reactors, needed to evolve to accommodate the safety characteristics and deployment potential of advanced reactor technologies.

In response, the NRC staff submitted SECY-20-0045, "Population-Related Siting Considerations for Advanced Reactors," which evaluated four policy options for updating population-related siting guidance.[5] In July 2022, the Commission formally approved Option 3 as a new approach for population-related siting evaluations for advanced reactors under SRM-SECY-20-0045, directing NRC staff to revise RG 4.7 to provide "technology-inclusive, risk-informed, and performance-based criteria to assess population-related issues in siting advanced reactors."[6] This decision explicitly acknowledged that the deterministic population thresholds developed for large light-water reactors are not appropriate for advanced reactor designs with fundamentally different safety characteristics. The Commission voted 2—1 in favor of revising guidance, recognizing that changes to Part 100 itself would require rulemaking.[7]

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[4] Nuclear Energy Innovation and Modernization Act, Pub. L. No. 115-439, 132 Stat. 5565 (2019)

[5] Nuclear Regulatory Commission, Population-Related Siting Considerations for Advanced Reactors, SECY-20-0045, May 2020, ML19143A194.

[6] Nuclear Regulatory Commission, *Population-Related Siting Considerations for Advanced Reactors*, SRM-SECY-20-0045, July 2022, ML22194A885.

[7] Chairman Hanson and Commissioner Wright voted to approve.

Then-Chair Kristine Svinicki voted in favor of Option 3 before her departure from the Commission, stating that it would appropriately credit "attributes of fuel design, inherent safety features, and other contributors to the retention of radionuclides within an advanced reactor facility."[8] She further noted that this approach was more likely to encourage integration of safety considerations early in design and siting and would better align with established NRC policy on advanced reactors.

The Advisory Committee on Reactor Safeguards (ACRS) also conducted a full review of SECY-20-0045 and issued a strong endorsement of Option 3. In 2019, the ACRS concluded that Option 3 was "the most reasonable of these approaches," citing its ability to provide design-specific results and its alignment with modern reactor safety features.[9] The Committee affirmed that this option was "technology-inclusive and risk-informed," and should be preferred to the outdated "one-size-fits-all" approach currently embedded in RG 4.7.[10] The ACRS explicitly noted that rigid population density thresholds—such as the 500 persons per square mile limit out to 20 miles—could unnecessarily preclude many suitable brownfield or repowering sites, and that current guidance failed to account for the smaller source terms and lower risk profiles of advanced reactor designs.

Despite these clear directives and endorsements, the revised RG 4.7 issued in 2024 fails to implement the dose-based, performance-oriented evaluation framework approved by the Commission and supported by the ACRS. Instead, the final guidance retains legacy population thresholds and deterministic screening criteria derived from large LWR assumptions without the flexibility that NEIMA, SECY-20-0045, and SRM-SECY-20-0045 envisioned.

Moreover, the approach codified in RG 4.7 Rev. 4 does not faithfully implement the methodology endorsed in SECY-20-0045. The staff's paper recognized that "attributes of advanced reactors are expected to provide a reduced likelihood of accidents and to result in a smaller and slower release of radioactive material in the unlikely event of an accident," and therefore, "may support

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[8] Nuclear Regulatory Commission, *Chairman Svinicki Response Sheet on SECY-20-0045: Population Related Siting Considerations for Advanced Reactors*, November 2020, ML21007A077.

[9] Nuclear Regulatory Commission, *Review of Draft SECY Paper, "Population-Related Siting Considerations for Advanced Reactors,"* Advisory Committee on Reactor Safeguards, October 2019, ML19277H031.

[10] Ibid.

siting them closer to population centers than large LWRs typically have been."[11] To address this, the staff recommended revising guidance to provide an alternative population-density criterion directly related to the potential radiological consequences of design-specific events. Yet the final guidance substitutes this intent with a deterministic rule requiring that the population density evaluation extend to twice the distance at which a hypothetical individual could receive 1 rem over 30 days. This "twice-the-distance" requirement is not performance-based. It is not "directly related to actual radiological consequence" as described in Option 3 of SECY-20-0045, but instead carries forward an arbitrary assumption about a larger surrounding area of potentially exposed population, despite the fact that dose levels at that extended distance may be negligible or zero.

This fails to meet the standard of tying siting suitability to modeled consequences and does not provide an appropriate margin reflective of risk or defense-in-depth. Rather than aligning with the risk-informed approach endorsed by the Commission, this approach preserves the very prescriptive rigidity that SECY-20-0045 and NEIMA sought to move beyond. In effect, the staff has not executed the Commission's direction, leaving critical issues unresolved. The NRC should treat this as a delayed action, not a new proposal, and move swiftly to fulfill the implementation of SRM-SECY-20-0045 as part of broader ADVANCE Act compliance.

2. Challenges with Current Population Density Criteria

RG 4.7 and subsequent draft updates, most recently RG 4.7 Rev. 4, introduced numerical population limits, including a 500 persons per square mile cap averaged over any radial distance up to 20 miles from the proposed site.[12] These thresholds are deterministically intended to limit societal risk by discouraging siting near densely populated areas, under the assumption that higher surrounding populations increase the difficulty of emergency planning and evacuation and the potential consequences of an accidental radiological release.

The population density *is* a deterministic standard, but the exclusion boundary itself is intended to be scalable based on the reactor's safety profile. While we recognize that a clear, deterministic

[11] Nuclear Regulatory Commission, Population-Related Siting Considerations for Advanced Reactors, SECY-20-0045, May 2020, Page 2, ML19143A194.

[12] Nuclear Regulatory Commission, *General Site Suitability Criteria for Nuclear Power Stations*, Regulatory Guide 4.7, Revision 4, Page 19, February 2024, ML23348A082.

threshold can improve regulatory efficiency by giving applicants certainty about what is required, the current approach is overly restrictive. It disqualifies many existing and potential sites where population growth has occurred over time, and it severely limits new siting opportunities near population centers due to the twice-the-distance buffer imposed in recent guidance.

The current approach is increasingly misaligned with both technological advances and the NRC's own evolving regulatory philosophy. The NRC has acknowledged through policy papers, including SECY-20-0045, that advanced reactor designs are likely to feature smaller source terms, enhanced passive safety systems, and reduced offsite dose consequences in the event of an accident.[13] These factors significantly alter the risk profile of a nuclear plant, diminishing the relevance of population density as a primary siting constraint.

The NRC's current population density criteria create several regulatory and practical challenges that directly impact the efficient and risk-informed siting of nuclear reactors, particularly advanced reactor designs. Continuing to apply rigid population density limits without accounting for differences in reactor design, safety systems, and accident consequences will risk disqualifying suitable sites without improving public safety or reducing risk by a significant margin.

The final version of RG 4.7 Rev. 4 retains the same core problems identified in BTI's comment on the draft guidance (DG-4034), and ultimately does not resolve the disconnect between population metrics and actual safety outcomes.

Disqualification of Viable Existing Sites

Strict population density thresholds are inconsistent with the NRC's continued licensing and oversight of existing nuclear power plants. BTI's analysis of evacuation time estimate (ETE) data for U.S. plants shows that approximately 15% of currently operating nuclear sites exceed the 500 persons per square mile threshold within 10 miles, despite having demonstrated safe operation over decades.[14] The current population density criteria would deem these sites unsuitable for the

[13] Nuclear Regulatory Commission, *Population-Related Siting Considerations for Advanced Reactors,* SECY-20-0045, May 8, 2020, https://www.nrc.gov/docs/ML1914/ML19143A194.pdf

[14] BTI Comment on DG-4034.

construction of new reactors, which raises serious questions about the ongoing validity and risk basis of the threshold itself.

Figure 1 shows that 17% of existing sites exceed the population density limit at some distance from the site. The analysis only includes permanent residents and, therefore, is conservative in estimating population density.

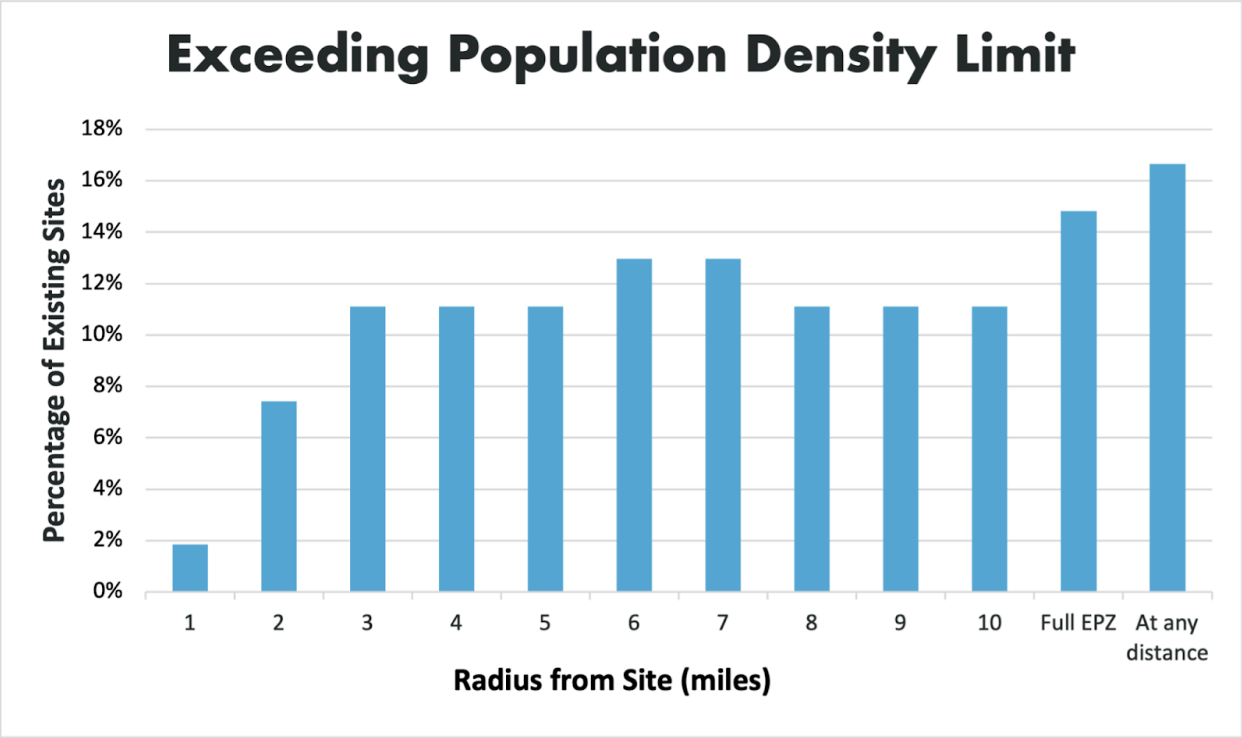

Figure 1: Portion of existing nuclear power sites that exceed the population density criterion.

RG 4.7 considers population density within about 5 years of initial plant approval. Population growth after approval is normal and expected. However, the population density limit as defined would preclude some existing nuclear power sites from consideration. The threshold is also likely to disqualify many retiring fossil-fuel plant sites, which are increasingly considered for repowering with advanced reactors. For example, population density near natural gas plants is

more than twice that of existing nuclear sites on average,[15] posing a direct barrier to transitioning these sites to nuclear power under current guidance.

These criteria are further complicated by non-uniform population clustering, such as towns located a few miles from potential sites, which disproportionately influence average density calculations and may disqualify a site even when total risk to the public remains low.

Figure 2 shows that population density typically increases 3-5 miles from the site due to small towns, which are typical within the vicinity of existing power plants. This represents a typical commute distance for a rural worker and should be expected.

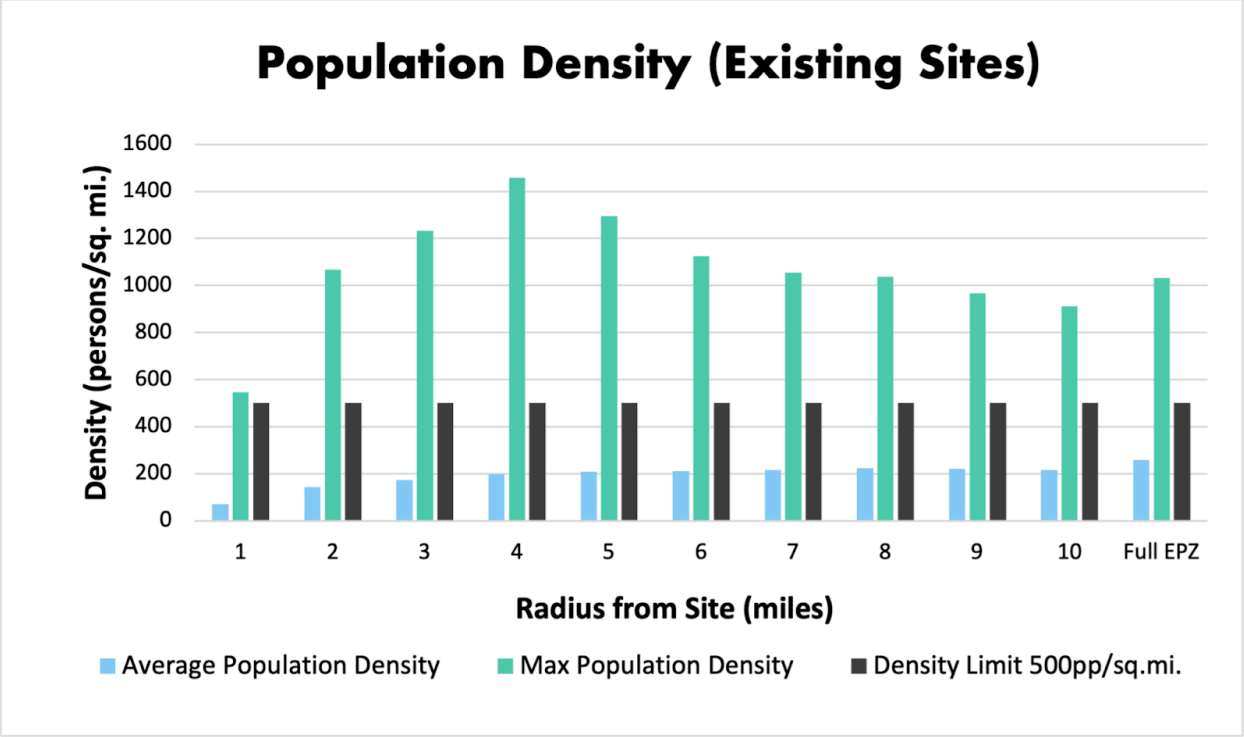

Figure 2: Population density minimum, mean, and maximum of existing nuclear power sites.

The result is that more sites will be considered unsuitable when the 1-rem dose boundary is closer to the site, such as at 2 miles, than when it is farther out at 3 miles or more (as defined in

[15] Carless, Travis Seargeoh Emile (2018). Framing a New Nuclear Renaissance Through Environmental Competitiveness, Community Characteristics, and Cost Mitigation Through Passive Safety. Carnegie Mellon University. Thesis. https://doi.org/10.1184/R1/6717320.v1

current regulatory guidance). This creates a counterintuitive outcome: sites with smaller source terms and more limited radiological impacts may be disqualified if the distance coincides with a small town, while sites with higher potential offsite doses remain eligible under the same population density threshold due to encompassing a larger area, which reduces population density. In effect, the framework penalizes safer designs by applying a population-based screening tool that fails to scale with risk.

This inconsistency has real-world consequences. Sites that the NRC has previously found acceptable for nuclear development, including those that meet all safety requirements, present no significant additional risk to surrounding populations, and have contributed positively to their communities, may now be excluded simply because they are also desirable places to live. Communities that have grown up around well-run nuclear or fossil plants may be punished for their own economic success, not because of any change in safety, but because static population thresholds do not adjust to reflect reactor design, consequence modeling, or societal benefit. This undermines the core intent of the ADVANCE Act and the NRC's revised mission to support deployment that serves both public safety and the broader public good.

Inflexibility to Reactor Design and Risk Profile

Applying the same population thresholds regardless of reactor size, source term, or safety features creates inconsistencies in risk management, where lower-consequence designs may face equal or greater siting hurdles than higher-consequence ones. Current population density thresholds creates a "one-size-fits-all" approach that treats a large, gigawatt-scale light-water reactor and a small modular reactor with passive safety systems as posing equivalent population-related risks, despite clear differences in potential offsite consequences.

For example, Kairos Power's Hermes reactor, recently approved for construction in Tennessee, uses a fluoride salt coolant that remains liquid at atmospheric pressure and significantly lowers the risk of coolant system failure. The company's safety case demonstrates that the reactor's design limits offsite consequences to well below regulatory thresholds, even under beyond-design-basis conditions.[16]

[16] Ed Blandford, Kairos Power LLC, *Kairos Power; Hermes Mandatory Hearing - Safety Panel (Slides)*, Exhibit KRS-003, October 19 2023, Slide 6, https://www.nrc.gov/docs/ML2328/ML23285A127.pdf

Similarly, TerraPower's Natrium reactor includes an advanced molten salt-based energy storage system. As detailed in TerraPower's 2024 topical report on design basis accidents with radiological release, the reactor's design ensures that even in the unlikely event of an accident, releases are inherently minimized, with no credible progression to large-scale radiological events under design basis conditions.[17] These enhanced safety characteristics directly support reforming siting criteria to recognize the lower risks posed by modern designs.

Furthermore, applying dated population thresholds contradicts the NRC's own recognition in SECY-20-0045 that advanced reactors may warrant "alternative siting considerations" due to their enhanced safety characteristics.[18] Federal analysis conducted by the Department of Energy's Gateway for Accelerated Innovation in Nuclear (GAIN) program supports the conclusion that population density criteria should differ for advanced reactors. A 2022 DOE/GAIN study found that the existing 500 persons per square mile threshold and 20-mile radius screening criteria were developed based on large LWR technology assumptions, promoting unnecessarily remote siting.[19] In contrast, for advanced reactors and SMRs with reduced source terms, passive safety features, and minimal offsite dose consequences, the NRC staff has recognized (through SECY-20-0045 and alternative siting guidance) that population proximity restrictions can and should be reduced.

Specifically, the GAIN study highlighted that for advanced reactor siting, population density considerations could appropriately be capped at distances of approximately 4 miles from the site center point, reflecting much smaller exclusion areas and low-probability consequence boundaries. This approach is already reflected in approved siting cases such as the TVA Clinch

[17] Terrapower, *Transmittal of TerraPower, LLC "Design Basis Accident Methodology for Events with Radiological Release," Revision 0*, TP-LIC-LET-0126, Project Number 99902100, ML24082A262.

[18] Nuclear Regulatory Commission, *Population-Related Siting Considerations for Advanced Reactors,* SECY-20-0045, May 8, 2020, ML19143A194.

[19] U.S. Department of Energy, *Investigating Benefits and Challenges of Converting Retiring Coals Plants into Nuclear Plants*, J. Hansen et al, INL/RPT-22-67964, September 2022, Page 10, https://gain.inl.gov/content/uploads/4/2023/02/DOE_Coal-to-NuclearReport_C2N_2022.pdf.

River Early Site Permit, which demonstrated emergency planning and radiological protection consistent with small exclusion boundaries.[20]

These findings reinforce the conclusion that continued reliance on static 20-mile averaging metrics and automatic exclusion of sites near moderate population centers does not reflect actual public health and safety risks for advanced reactors. It also unnecessarily limits deployment, directly contradicting the risk-informed, performance-based regulatory modernization goals of the ADVANCE Act.

Similarly, in the emergency preparedness rulemaking for SMRs and non-LWRs, the NRC established a performance-based framework that allows applicants to propose customized EPZ boundaries based on dose modeling and accident scenarios, rather than requiring a default 10-mile zone.[21] The same logic should apply to population-related siting metrics, but it has not been carried over into RG 4.7 Rev. 4 nor 10 CFR Part 100.

If EPZ boundaries can be sized to reflect reactor-specific risk, population density metrics should follow suit. Treating a 300 MWe passively safe reactor as equivalent to a 1,200 MWe large PWR from a population risk standpoint distorts the logic of risk-informed regulation. It also pressures developers to pursue remote greenfield sites, often at higher cost, longer timelines, and higher environmental impacts, when existing brownfield or infrastructure-rich locations could be equally safe and more beneficial to the public. This is also contradictory to Congressional intent in the ADVANCE Act.

Barriers to Repowering Brownfield Sites

One of the clearest opportunities for accelerating deployment of advanced reactors is through repowering retiring coal and natural gas plants. These sites are already connected to the grid, often have permitted water use and infrastructure, and are embedded in energy-aware

[20] U.S. Department of Energy, *Investigating Benefits and Challenges of Converting Retiring Coals Plants into Nuclear Plants*, J. Hansen et al, INL/RPT-22-67964, September 2022, Page 11, https://gain.inl.gov/content/uploads/4/2023/02/DOE_Coal-to-NuclearReport_C2N_2022.pdf.

[21] Nuclear Regulation Commission, Emergency Preparedness for SMRs and Other New Technologies, 88 Fed. Reg. 37332, 2023, ML21200A195.

communities. Yet, the current population density criteria present a systematic barrier to utilizing these locations.

Many coal and natural gas facilities are located near population centers, particularly along transportation corridors and in regions with existing grid infrastructure. Research indicates that the population density surrounding natural gas plants is more than twice as high as that surrounding existing nuclear plants.[22] Advanced reactors are ideally suited to replace these fossil units with their smaller footprints and lower risk profiles. But under today's guidance, such sites are likely to be excluded based on static population density calculations that do not reflect their true safety profile or societal benefit.

Crucially, Section 206 of the ADVANCE Act directs the NRC to evaluate and revise regulations, guidance, and policies to enable efficient, timely, and predictable licensing of advanced reactors at brownfield and retired fossil fuel sites. The statute specifically directs the NRC to consider siting and operational efficiencies such as:

- Reuse of existing infrastructure (e.g., switchyards, water intake, cooling systems, roads, rail access);
- Use of early site permits and standardized applications;
- Utilization of existing environmental and emergency preparedness analyses;
- Community engagement and historical experience with energy production.

Moreover, the NRC itself has recognized the value of brownfield repowering. In SECY-20-0045, the staff stated that expanding siting flexibility could "substantially increase the number of available sites" for advanced reactors. Yet despite this acknowledgment, neither RG 4.7 Rev. 4 nor current 10 CFR Part 100 provisions provide a risk-informed pathway for these projects.

Applying inflexible population limits to these sites forecloses some of the most practical, cost-effective opportunities for transitioning fossil sites to nuclear generation despite the public policy benefits of reusing existing infrastructure and minimizing land use impacts. These are

[22] Carless, Travis Seargeoh Emile (2018). Framing a New Nuclear Renaissance Through Environmental Competitiveness, Community Characteristics, and Cost Mitigation Through Passive Safety. Carnegie Mellon University. Thesis. https://doi.org/10.1184/R1/6717320.v1

precisely the kinds of benefits the NRC is now required to consider under its updated mission and Section 206 of the ADVANCE Act.

Misalignment with Societal Risk

Current guidance relies on average population density calculations over radial distances from the reactor site. This method fails to account for non-uniform population distributions, such as small towns or suburbs located a few miles from a potential site. These local clusters can cause the overall density average to exceed the regulatory threshold, disqualifying sites despite low total population exposure and minimal risk.

As described in BTI's comment on DG-4034 (now RG 4.7 Rev. 4), this effect leads to counterintuitive outcomes where reactors with larger source terms and greater offsite risk can sometimes qualify under the population density criteria more easily than smaller, inherently safer designs, simply due to differences in local geography and demographics.[23]

Under the framework outlined in RG 4.7 Rev. 4, the NRC requires that population density be evaluated not just within the distance at which a member of the public could receive 1 rem over 30 days in a postulated event, but within a buffer extending to twice that distance. In other words, if a reactor design models a 1-rem dose boundary at 2 miles, the applicant must demonstrate compliance with the population density threshold across an area extending out to 4 miles. This is a conservative construct intended to ensure that the surrounding population exposure remains limited even in rare events.

Because the 1-rem dose boundary is a function of the reactor's source term and safety features, advanced reactors with lower offsite consequences tend to have smaller 1-rem distances (for example, 1 mile instead of 2). However, under RG 4.7 Rev. 4, these designs must still demonstrate that the population density remains below the threshold out to twice the 1-rem distance. This means a reactor with a smaller exclusion area is evaluated over a proportionally larger surrounding area, where population density is often higher. Instead of being credited for their lower risk, these designs may be penalized for being located near small towns or suburbs that fall within the expanded buffer zone.

[23] BTI Comment on DG-4034.

The area of a circle increases non-linearly with distance from the center (radius). Population as a function of a population density limit (in this case 500 pp/sq.mi.) increases proportionally to area. Therefore, the total population, held at a constant population density, increases more quickly the farther from the center. An alternative distance metric can reduce the challenges associated with the twice-the-distance proposed metric and be more aligned with the performance objective of controlling societal risks.

The cumulative maximum potential population relative to different distances from the site. As shown in *Figure 3*, the twice the distance of the 1-rem dose in RG 4.7 Rev. 4 results in a total potential population that quickly diverges from the 1-rem distance population in a non- linear manner. It also does not reflect that the source term decreases with distance from the source.

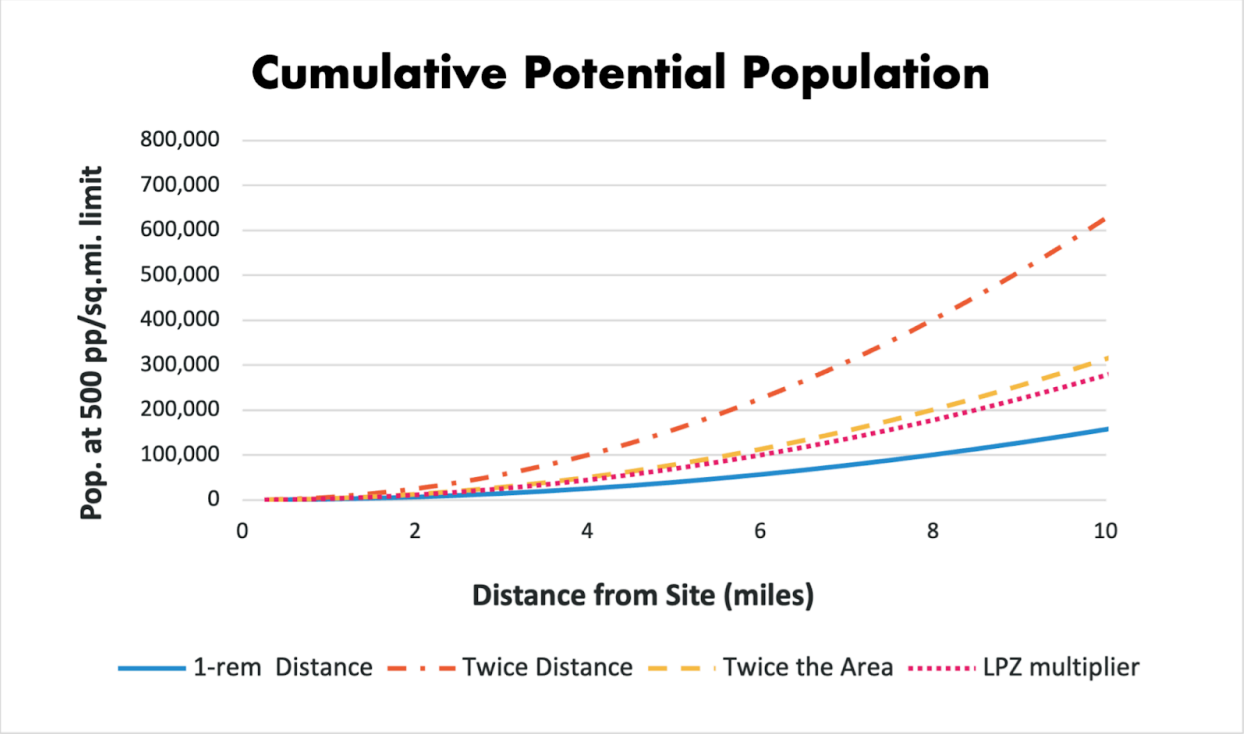

Figure 3: Potential population within a specified distance from a site at a uniform population density of 500 persons per square mile.

The use of fixed distances and density caps imposes an indirect, proxy-based control on societal risk, rather than assessing the actual public health consequences of a credible accident scenario. These metrics were deterministic assumptions dating to a time when a simplified approach was

needed to increase regulatory efficiency and certainty, in part because data and computational power were limited. These assumptions were used for a single radius and are not well designed for a scalable methodology, and introduce unintended consequences.

Current guidance uses population within a 20-mile radius as a screening tool, even though this does not scale proportionally with dose consequence or safety concern. BTI previously proposed alternative approaches based on √2 or 1.33 multipliers to scale population more realistically with societal risk, compared to the twice-the-distance multiplier adopted in the final guidance. A multiplier of √2 scales to twice the area. At a fixed population density that also scales to twice the total population.

Similarly, NEI noted in public comments on Draft RG 4.7 Rev. 4 that requiring siting distances of up to twice the distance to 1 rem over 30 days is not only inconsistent with past LWR licensing practice, but also introduces unnecessary conservatism. Their evaluations show that this framework could result in dose protections *seventy* times more stringent than the historical standard.[24]

These compounding conservative assumptions, including the use of extreme weather scenarios and maximum release postulates, can exaggerate potential public health risks far beyond realistic levels. This method misaligns societal risk management with actual accident consequences, penalizing advanced reactors and brownfield sites that offer substantial environmental and energy security benefits. Alternative, risk-informed metrics, such as those based on calculated dose consequences or probabilistic risk assessment, would more appropriately address societal risk without arbitrarily disqualifying sites based on population distribution alone.

[24] Kati Austgen, Nuclear Energy Institute,Comments on Draft Regulatory Guide (DG), DG-4034, "General Site Suitability Criteria for Nuclear Power Stations." (Docket ID: NRC—2023—0153) (Federal Register Notice 88 FR 71777), November 2023, ML23326A031.

2. Alignment with the ADVANCE Act

The population density requirements applied to nuclear reactor siting must be reconsidered in light of the statutory directives set forth in the ADVANCE Act of 2024.[25] Congress enacted the ADVANCE Act with the clear purpose of removing regulatory barriers to enable the deployment of advanced nuclear technologies, modernize the NRC's regulatory framework, and allow the United States to realize the societal benefits of expanded nuclear energy deployment.

The following ADVANCE Act provisions are of utmost relevance to population density and population center considerations:

Section 206 – Regulatory Issues for Nuclear Facilities at Brownfield Sites

Section 206 of the ADVANCE Act requires the NRC to evaluate whether its regulations, guidance, and policies should be modified to support efficient, timely, and predictable licensing of nuclear facilities at covered sites, defined to include retired fossil fuel sites and brownfields. This section reflects Congress's recognition that reusing existing industrial sites is one of the most practical and cost-effective pathways for deploying advanced reactors, and that the NRC's siting policies must evolve to enable this opportunity.

In particular, Section 206 directs the Commission to consider licensing strategies that leverage existing infrastructure (such as transmission systems, water intakes, and access roads), previous environmental reviews, and the community's historical experience with energy production. It also encourages the use of tools like early site permits, standardized applications, and plant parameter envelopes to streamline deployment at these sites.

To comply with the ADVANCE Act, the NRC must ensure that population density considerations do not undermine the ability to license advanced reactors at brownfield or retired fossil sites, particularly where safety can be demonstrated through robust technical analysis and where the benefits of site reuse are substantial.

[25] Public Law No: 118-22.

Section 207 – Combined License Review Procedure

Section 207 requires the NRC to identify and remove regulatory barriers that unnecessarily impede the deployment of advanced nuclear technologies. As demonstrated in BTI's analysis of DG-4034, strict population density criteria have already been shown to disqualify approximately 15% of existing nuclear sites, and they pose significant obstacles to repowering retiring fossil-fuel plants, which tend to be located near higher population densities.[26] 207 requires expedited review for siting at or adjacent to existing sites. The current RG, as shown by our analysis, would preclude the use of a large portion of those existing sites, or require extra justification and approval for their use, adding additional work and layers that reduce, not improve, efficiency.

Constructing new plants on or near existing sites does not increase risk to the population unless there is a common mode failure. Current population siting constraints inhibit deployment without a commensurate safety benefit and therefore represent precisely the type of regulatory barrier that Congress intended the NRC to eliminate under Section 207.

Section 501 – Mission Alignment

Section 501 of the ADVANCE Act required the NRC to revise its mission statement to ensure that regulation of civilian nuclear energy and radioactive materials is conducted efficiently and in a way that does not unnecessarily limit the benefits of nuclear energy to society. On January 24, 2025, the Commission formally approved an updated mission statement[27] that now reads:

> The NRC protects public health and safety and advances the nation's common defense and security by enabling the safe and secure use and deployment of civilian nuclear energy technologies and radioactive materials through efficient and reliable licensing, oversight, and regulation for the benefit of society and the environment.

This mission update confirms the Commission's obligation to consider societal benefits when carrying out its regulatory responsibilities. The explicit inclusion of "for the benefit of society and

[26] BTI Comment on DG-4034.

[27] Nuclear Regulatory Commission, *Mission Statement Update Options Pursuant to Subsection 501(a) of the ADVANCE Act of 2024*, SRM-SECY-24-0083, January 24, 2025, ML25024A040.

the environment" establishes a clear policy foundation for revisiting regulatory requirements (i.e., prescriptive population density thresholds) that may unnecessarily restrict advanced nuclear deployment without delivering commensurate safety improvements.

Population density criteria that automatically disqualify sites based solely on fixed, design-agnostic thresholds directly undermine this updated mission. This regulatory approach to population density prevents projects that would otherwise provide substantial societal benefits, such as reliable clean electricity, reduced carbon emissions, and economic revitalization of retiring fossil-fuel sites. Under the revised mission, the NRC must ensure that its siting regulations enable these benefits unless doing so would compromise reasonable assurance of adequate protection of public health and safety.

Accordingly, the updated mission statement reinforces the need to modernize population density regulations to align with risk-informed, performance-based principles and support deployment of advanced nuclear technologies in a manner consistent with the full intent of the ADVANCE Act.

3. Risk-Informed, Performance-Based Modernization

Together, these challenges demonstrate that the NRC's current population density criteria are becoming increasingly outdated, inconsistent with the risk-informed principles the agency seeks to uphold, and incompatible with the future of advanced nuclear deployment. To support the goals of the ADVANCE Act and align with the NRC's updated mission to enable the safe and secure use of nuclear technologies for the benefit of society and the environment, BTI recommends several key reforms to population density regulations and guidance.

Modernize 10 CFR Part 100 and RG 4.7

The current population criteria in 10 CFR §100.21(h) were developed decades ago in the context of large light-water reactors. RG 4.7 Rev. 4, fails to provide a clear, risk-informed, performance-based pathway for advanced reactor developers. These frameworks must be updated to reflect advances in reactor design, safety modeling, and consequence analysis.

BTI supports revising 10 CFR Part 100 to eliminate static thresholds and adopt a scalable, risk-informed framework that ties siting suitability to reactor-specific safety characteristics and

offsite dose consequences. For example, rather than applying a fixed threshold of 500 persons per square mile averaged over a 20-mile radius, the NRC should allow applicants to demonstrate acceptability based on modeled risk consistent with current approaches to EPZ sizing and safety-case licensing.

The Commission should also update guidance on how distance from the reactor factors into societal risk. Current methods that double the 1-rem distance to define a population screening area result in a fourfold increase in affected population, due to geometric scaling, without a proportional safety justification. Alternative approaches, such as area-based population scaling (e.g., a √2 multiplier), would more accurately reflect total public exposure and align with the goal of managing societal risk rather than enforcing arbitrary buffers.

Reconcile Population Criteria with Emergency Planning and Safety Case Evaluations

BTI supports clarifying that for advanced reactors with low source terms and EPZs that do not extend beyond the site boundary, there is no safety basis for requiring the low-population zone (LPZ) or population center distance to extend beyond that boundary. While the existing provisions in §§100.1 and 100.21 imply this flexibility, they do not offer a coherent, risk-aligned approach to population density evaluation. As a result, applicants may be required to demonstrate compliance with outdated distance formulas even when their designs pose minimal offsite risk.

Population-related siting criteria must be considered as part of an integrated review framework. Under the current structure, siting evaluations, EPZ determinations, ingestion pathway assessments, and shielding requirements are conducted in isolation. This fragmented process creates the potential for conflicting outcomes; for example, when a reactor's emergency planning analysis demonstrates negligible offsite dose but the site is disqualified due to a nearby town that slightly increases population density beyond an arbitrary threshold.

The NRC should move toward a unified review framework in which population-related criteria are evaluated in concert with the applicant's broader safety case. This would bring the siting policy in line with modern licensing principles under Part 53 and other risk-informed initiatives, including the 2023 EPZ modernization rule. It would also allow the agency to credit reactor safety

innovations and consequence modeling in a way that supports regulatory efficiency and public health protection.

Enable Use of Existing Nuclear and Retired Fossil Plant Sites

Population density criteria should not preclude the use of existing nuclear sites or retiring fossil plant sites that already host energy infrastructure and are ideal candidates for nuclear redevelopment. The NRC's current framework creates unnecessary hurdles for these projects, even when the proposed reactor design would pose minimal risk to surrounding communities.

To address this, the NRC should develop a clear and risk-informed pathway for siting at higher-density legacy fossil sites, consistent with the intent of Sections 206, 207, and 501 of the ADVANCE Act. The agency should also provide categorical acceptance or a presumption of suitability for sites with existing reactor licenses, early site permits, or recent environmental reviews that remain valid under current safety standards. These actions would reduce uncertainty, avoid duplicative review, and ensure that legacy infrastructure can be reused to support an affordable, secure, and clean energy future.

4. Conclusion

The NRC has an important opportunity and a statutory obligation under the ADVANCE Act to modernize how it evaluates population density in nuclear reactor siting. As detailed in this comment, current criteria are based on decades-old assumptions developed for large light-water reactors and no longer reflect the safety case or deployment realities of advanced nuclear technologies. These prescriptive thresholds risk excluding viable sites, delaying projects, and imposing costs without delivering commensurate public safety benefits.

Through public meetings, policy papers, and published guidance, the NRC has acknowledged that advanced reactors warrant a different approach. And yet, RG 4.7 Rev. 4 and 10 CFR Part 100 continue to rely on static population limits and distance-based metrics that do not account for passive safety systems, reduced source terms, or site-specific risk modeling. This disconnect undermines the agency's stated goal of risk-informed, performance-based regulation and it

directly conflicts with multiple provisions of the ADVANCE Act, including Sections 206, 207, and 501.

BTI urges the NRC to proactively revise its population density regulations and guidance. These changes are essential to enabling a clean energy future that is affordable, secure, and aligned with the NRC's updated mission to serve the public good. BTI appreciates the Staff's and Commission's engagement on these issues and welcomes the opportunity to support continued implementation of the ADVANCE Act in a manner that upholds safety while unlocking the benefits of next-generation nuclear energy.

Sincerely,

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