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NRC Staff Draft White Paper
Alternative Approaches to Address Population-Related Siting Considerations

Introduction

The NRC has a longstanding policy of considering the siting of nuclear power reactors as a factor in ensuring that multiple levels of defense-in-depth are provided to protect public health and safety in the event of an accident. In SECY-20-0045, the NRC staff provided options to the Commission for possible changes to the population-density criterion in Regulatory Guide (RG) 4.7 for meeting the siting requirements of Section 100.21(h) in Title 10 of the *Code of Federal Regulations* (10 CFR) for potential reactors with attributes that could support siting them closer to population centers than large light water reactors (LWRs) typically have been sited. In the associated staff requirements memorandum (SRM),[1] the Commission approved the staff's recommended option to revise the guidance in RG 4.7 to include technology-inclusive, risk-informed, and performance-based criteria for population densities that are based on estimates of radiological consequences from design-specific events (Option 3 in SECY-20-0045). The Commission also directed the staff, with respect to a traditional dose assessment approach, to "provide appropriate guidance on assessing defense-in-depth adequacy and establishing hypothetical major accidents to evaluate." This white paper proposes a set of attributes that applicants should address in the siting analysis, including establishing a release, performing a hazard assessment, considering uncertainty, and demonstrating adequate defense-in-depth. In addition, this white paper proposes three different approaches for estimating offsite consequences to inform the alternative population-related siting considerations for advanced reactors.

Background

Requirements related to siting of nuclear power reactors are included in NRC regulations in 10 CFR Part 100, "Reactor site criteria;" 10 CFR Part 50, "Domestic licensing of production and utilization facilities;" and 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear

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[1] SRM-SECY-20-0045, "Staff Requirements – SECY-20-0045 – Population-Related Siting Criteria for Advanced Reactors," dated July 13,2022 (ADAMS Accession No. ML22194A885)

power plants."[2] Useful background information on the history of siting requirements is provided in the Federal Register Notice, "Final Rule: Reactor Site Criteria Including Seismic and Earthquake Engineering Criteria for Nuclear Power Plants" (61 FR 65157; December 11, 1996), and documents such as NUREG-0625, "Report of the Siting Policy Task Force,"[3] ORNL/TM-2019/1197, "Advanced Reactor Siting Policy Considerations,"[4] and SECY-20-0045, "Population-Related Siting Criteria for Advanced Reactors."[5]

Section C.4. of RG 4.7, "General Site Suitability Criteria for Nuclear Power Stations,"[6] provides staff regulatory guidance on meeting the requirements in 10 CFR Part 100 for nuclear reactor licensees to establish an exclusion area, a low population zone, and a minimum distance to the nearest densely populated center containing more than about 25,000 residents.

Section C.5 of RG 4.7 provides staff regulatory guidance on meeting the requirements in 10 CFR 100.21(h), which states:

> 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.

The existing guidance in RG 4.7 provides one way that an applicant can meet the requirements of 10 CFR 100.21(h) if the population density averaged over any radial distance out to 20 miles from the nuclear plant does not exceed 500 persons per square mile (ppsm). The inclusion of population density requirements in 10 CFR Part 100 serve to limit societal risks in terms of the number of people affected by a release and reflect consideration of low frequency event sequences (referred to as Class 9 accidents during the initial development of Part 100). The existing guidance in Section C.5 of RG 4.7 establishes a fixed distance of 20 miles out to which population density is assessed for any new application. The 20-mile distance was based on insights from probabilistic risk assessments and other studies associated with light-water reactor designs. Design and site-specific analyses are not required during the licensing process to further support or confirm the basis for the population density (500 ppsm) or the associated area (20-mile radius).

Regulations in 10 CFR Parts 50 and 52 address the design of nuclear reactors and relate to the siting requirements in 10 CFR Part 100 in that the consequences of a major accident—as represented by the calculated total effective dose equivalent (TEDE) to a hypothetical individual—are below reference values at the boundary of a plant's exclusion area and low population zone. Although often referred to as siting analyses because the criteria are defined

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2 Note that siting is also a significant focus of 10 CFR Part 51, "Environmental protection regulations for domestic licensing and related regulatory functions," but Part 51 requirements, including the need to assess severe accident mitigation alternatives, are outside of the scope of this guidance.

3 NUREG-0625, "Report of the Siting Policy Task Force," (ADAMS Accession No. ML12187A284)

4 ORNL/TM-2019/1197, "Advanced Reactor Siting Policy Considerations

5 SECY-20-0045, "Population-Related Siting Criteria for Advanced Reactors," dated May 8, 2020 (ADAMS Accession No. ML19262H055)

6 Regulatory Guide (RG) 4.7, "General Site Suitability Criteria for Nuclear Power Stations," (ADAMS Accession No. ML12188A053)

in terms of the exclusion area boundary (EAB) and the low population zone (LPZ), the Parts 50 and 52 source term and dose calculations tend to influence plant design aspects such as containment leak rate or filter performance rather than siting. No specific source term is referenced in Parts 50 or 52. Rather, the source term should be one that is based on a major accident generally assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products. Hence, the guidance in RG 4.7 can be utilized with the source terms traditionally used for light-water reactors[7], or used in conjunction with revised accident source terms and non-light-water-reactor design-specific accident source terms. The siting analyses that use criteria considering doses at the EAB and LPZ have not historically been performed to confirm or adjust the considerations of population densities used to meet requirements in 10 CFR 100.21(h).

Discussion

The Commission approved alternative population-related criteria in SRM-SECY-20-0045 where instead of locating a reactor in an area where the population density does not exceed 500 ppsm out to 20 miles from the reactor, an applicant can demonstrate compliance with 10 CFR 100.21(h) by siting a nuclear reactor in a location where the population density does not exceed 500 ppsm out to a distance equal to twice the distance at which a hypothetical individual could receive a calculated TEDE of 1 rem over a period of 1 month from the release of radionuclides following postulated accidents. For assessing population-related factors under the alternative approach, the consideration of transient populations and the gathering and prediction of population data in relation to the timing of licensing decisions is the same as described in Section C.5 of RG 4.7.

The alternative population-related siting criteria themselves are independent of reactor design, but the calculation of potential doses from postulated accidents to be considered in the criteria are expected to reflect specific reactor designs and analytical approaches. SECY-20-0045 introduces the consideration of design features to limit the consequences of low frequency event sequences and provide flexibility in meeting the requirements of 10 CFR 100.21(h) in a manner similar to that used to determine or confirm the EAB and LPZ in the traditional siting analyses. Because the alternative approach allows the consideration of design attributes and associated analyses in determining the area in which population density is considered, the revised guidance should address how event analyses and models for the potential release of radionuclides support meeting siting criteria that contribute to ensuring defense-in-depth is provided for protecting populations near nuclear power plants.

In SECY-20-0045, the NRC staff discussed two general approaches to siting analyses and making regulatory decisions related to reactor designs and reactor sites. One approach, discussed in SECY-20-0045, involves the use of the methodology described in RG 1.233, which is often referred to as the licensing modernization project (LMP) methodology for identifying and analyzing licensing basis events, determining appropriate special treatments for plant structures, systems, and components (SSCs), and assessing defense-in-depth. The LMP methodology includes the assessment of potential consequences for a spectrum of event sequences using probabilistic risk assessment (PRA) approaches and as needed, event-specific or mechanistic consideration of the movement of radionuclides past various barriers.

[7] Technical Information Document (TID) 14844, "Calculation of Distance Factors for Power and Test Reactor Sites," dated March 23, 1962 (ADAMS Accession No. ML021750625) and RG 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," (ADAMS Accession No. ML003716792)

The second approach is the traditional prescriptive and conservative source term analysis as described in RG 1.183, which involves the modeling of containment performance to ensure that it limits offsite consequences assuming the introduction of a prescribed mix of radionuclides. The mix of radionuclides or "source term" have been defined from various studies and analyses to bound events involving the breach of other barriers. The two approaches are represented in Figure 1 by the two paths to determining the releases of radionuclides for possible atmospheric dispersion and resultant doses to members of the public.

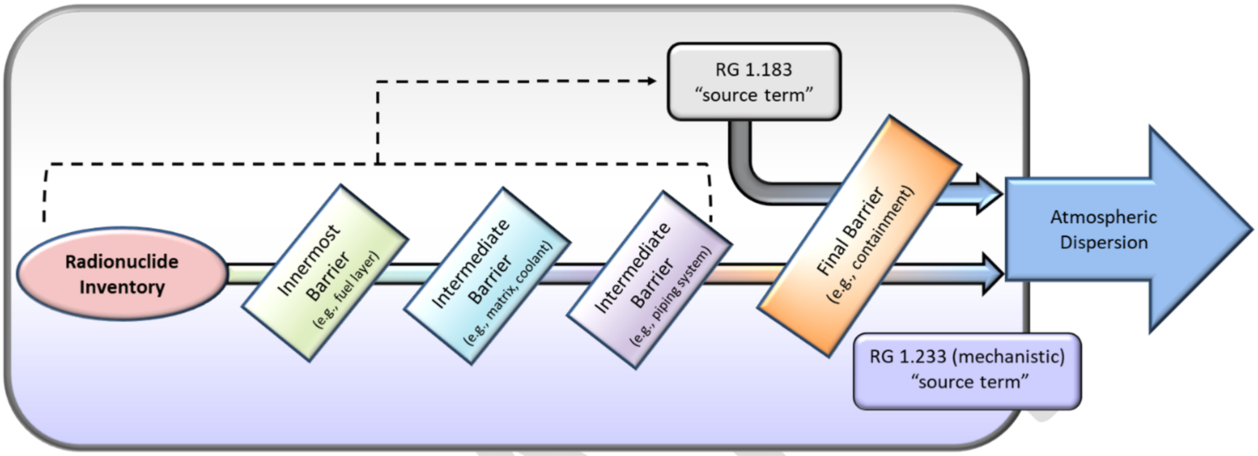

Figure 1: Approaches for estimating radiological releases

The following sections outline how these two basic approaches may be applied to both non-LWR and LWR technologies to support estimating offsite consequences to inform the alternative population-related siting considerations. Acceptable analyses in general can be thought of along a continuum of realism and rigor of the analysis while balancing how much conservatism and margin are imposed between expected conditions and analytical assumptions. More conservative analyses often lead to large safety margins on various design features, but such an approach can simplify the analyses while still demonstrating adequate conservatism to address uncertainty. More realistic and rigorous analyses involve more complex modeling of event sequences and contributions from various barriers but may justify flexibility in plant design or needed programmatic controls. Due to the wide variety of advanced reactor designs and safety approaches, the spectrum of conditions and tradeoffs along this continuum does not lend itself to prescriptive guidance similar to RG 1.183. Therefore, the staff provides the following list of key attributes for siting analysis that should be considered whether an emphasis is placed on simplifying the analyses or justifying flexibilities in plant design and operation.

- Perform a comprehensive event assessment to identify all credible events
- Select an event or events that bound the credible events in terms of parameters (e.g., temperatures, stresses) to determine conservative estimates of the radionuclide release(s) from the first barrier (and potentially intermediate barriers) to be used for the siting evaluation
- Consider uncertainties related to the performance of the barriers commensurate with the scope of the analysis performed
- Demonstrate adequate defense-in-depth for confining and retaining radionuclides considering the uncertainties related to barrier performance

The staff anticipates three types of advanced reactor applications: (1) non-LWR technologies using the LMP methodology; (2) LWR technologies using more traditional approaches to assessing the potential consequences from reactor accidents; and (3) non-LWR technologies not using the LMP methodology and choosing to use a more traditional approach to establish the requirements for a containment-type barrier for limiting the release of radionuclides. The following paragraphs provide proposed options for estimating offsite consequences to inform the alternative population-related siting considerations for each of these types of advanced reactor applications.

(1) Non-LWR Technology Applications Using Regulatory Guide 1.233 (LMP Methodology)[8]

As described in SECY-20-0045, applicants for licenses, certifications, and approvals for non-LWR designs under Parts 50 or 52 can use the methodology described in RG 1.233 for the identification and analyses of licensing basis events, including those used for siting-related assessments. The methodology specifically addresses the staff's key attributes described above and includes the analyses of a wide range of event sequences to gain design and operational flexibilities. For an applicant using a methodology like that described in RG 1.233, the results from the design basis accidents (DBA) analyses are used to determine or confirm the boundaries of the exclusion area and low population zone by comparing the calculated consequences against the requirements in 10 CFR 50.34(a)(1)(ii)(D) or the corresponding requirements in Part 52. The DBA analysis under RG 1.233 is a deterministic, conservative analysis approach that is similar to the DBA analyses performed for new and operating reactors in accordance with NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Chapter 15, "Transient and Accident Analyses." The staff anticipates that an applicant using this approach may determine the need to request an exemption from the regulations in 10 CFR 50.34 or 52.79 if the DBA does not involve the equivalent of significant core damage because those regulations require an assumed "major accident" for demonstrating the adequacy of traditional containment structures in terms of confirming that doses at the boundaries of the exclusion area and LPZ are below the reference values provided in the regulations.

Applicants using a methodology like that described RG 1.233 would use the licensing basis events categorized as design-basis events and beyond-design-basis events to estimate potential offsite doses for use in determining the distance out to which the population density should be less than 500 ppsm.[9] The estimated doses from design-basis events and beyond-design-basis events are calculated for the 30-day period following the initiation of the release to determine the distance at which the dose to a hypothetical individual would exceed 1 rem TEDE. The calculation of offsite doses should be in accordance with NRC accepted methodologies, including associated computer models for the plant response to an accident, the performance of various barriers to the release of radioactive materials, and the atmospheric dispersion of any released radioactive materials to areas surrounding the plant.[10]

[8] The scope of RG 1.233 is limited to non-LWRs. The staff may in the future expand the applicability of RG 1.233 to LWRs as part of the guidance development for ongoing rulemakings.

[9] The methodology endorsed in RG 1.233 includes also specific steps to assess defense-in-depth provided by the combination of plant design, siting, and programmatic controls.

[10] The NRC's acceptance of methodologies and computer models can be via endorsement of generally accepted methods, standards, and practices (e.g., regulatory guide for a consensus standard or approval of generic topical report) or as part of specific applications. Such acceptances can be for broad methodologies such as RG 1.247,

Demonstrating that the population density for a subject site does not exceed 500 ppsm within the circular area defined by a radius of twice the distance at which the 1 rem TEDE is estimated for potential design-basis and beyond-design-basis events is sufficient to meet the requirements of 10 CFR 100.21(h). In the case that an applicant can show that no design-basis events (DBEs) or beyond design basis events (BDBEs) result in an offsite dose exceeding 1 rem TEDE for the 30-day exposure period, the limiting population-related requirement may be that the site needs to be outside of any population center of approximately 25,000 persons.

(2) LWR technology Applications Using Regulatory Guide 1.183 plus Severe Accidents (Traditional Approach)

As described in SECY-20-0045, the alternative approach for considering population density near a nuclear power plant can also be applicable to light-water reactors using more traditional approaches to assessing the potential consequences from reactor accidents. This approach addresses the key attributes described above and usually involves stylized or deterministic analyses for various barriers to support the identification of design requirements and technical specifications for systems designed to control reactivity, provide core cooling, and maintain containment integrity. The siting analysis can be viewed as the last in a series of conservative analyses used to show that a nuclear plant is designed and sited such that it introduces no undue risk to public health and safety. The existing guidance in Section C.4 of RG 4.7 and RG 1.183 address the siting assessments and determination or confirmation of the boundaries of the exclusion area and low population zone based on the assumption of a major accident, the performance of containment and other systems included in a design to limit fission product release, and the characteristics of the subject site. An applicant may also use the analyses of a major accident using guidance such as RG 1.183 plus the evaluation of potential severe accidents that challenge the containment to evaluate an alternative to the assumed 20-mile distance from the plant for which population density is not to exceed 500 ppsm.

The analyses supporting an alternative to the guidance in Section C.4 of RG 4.7 would be used to estimate the distance at which a hypothetical individual would experience a dose of 1 rem TEDE over the 30-day period following the initiation of a release. The radiological source term from RG 1.183 can be used along with insights from generic or design-specific analyses to address the performance of containment and other systems included to limit the release of radionuclides from severe accidents. At a minimum, the containment leakage will be assumed to be the same as that used for the evaluation of the EAB and LPZ. The magnitude and timing of possibly greater releases to the environment should be assumed based on the analyses of accident progression and containment performance from the assessment of severe accidents for the as-designed plant (including potential severe accident design features). While allowing for a design-specific accounting of the likelihood and consequences of severe accidents, the approach provides a uniform methodology for establishing the distance for considering population density and thereby serves the underlying purposes of facilitating emergency planning and limiting potential doses to large numbers of people in the event of reactor accidents. The continued consideration of population density provides an element of defense-in-depth that complements the other layers provided by compliance with requirements associated with the plant design (e.g., general design criteria) and programmatic controls.

"TRIAL - Acceptability of Probabilistic Risk Assessment Results for Non-Light Water Reactor Risk-Informed Activities," or combinations of individual computer codes and related simulations.

Therefore, demonstrating that the population density for a subject site does not exceed 500 ppsm out to twice the calculated distance at which the 1 rem TEDE is estimated for a major accident with consideration of containment performance during severe accidents is sufficient to meet the requirements of 10 CFR 100.21(h). In the case that an applicant can show that the calculated offsite dose does not exceed 1 rem TEDE for the 30-day exposure period, the limiting population-related requirement may be that the site needs to be outside of any population center of approximately 25,000 persons.

(3) Non-LWR Technology Applications Using Traditional Analysis of Containment Type Barrier (Not Using an LMP Methodology)

Non-LWR applicants choosing not to use a methodology like that in RG 1.233 and the related event-specific modeling of mechanistic source terms may use a more traditional approach to establish the requirements for a containment-type barrier for limiting the release of radionuclides.[11] Since this approach will be seen as limiting for the required analyses compared to a more fully developed mechanistic source term for a range of event sequences, it would require the development of a conservative, design-specific estimate of a mixture of radionuclides breaching other barriers like that provided in RG 1.183 for LWRs. That mixture of radionuclides or source term along with associated energy additions (e.g., accounting for increased temperatures and pressures) from design-basis accidents are used to confirm or establish performance requirements, including maximum leak rates, for the containment features using the existing criteria for doses at the EAB and LPZ. As is provided in RG 1.183 for LWRs, the non-LWR source term for the traditional siting analyses related to the EAB and LPZ should be expressed in terms of times and rates of appearance of radioactive fission products released into the containment-type feature, the types and quantities of the radioactive species released, and the chemical forms for those radionuclides expected to significantly influence the public dose. As described above in the traditional approach for LWRs (Item 2), this conservative source term introduced to the interior of a containment-type feature should also be used in combination with an assessment of containment performance under severe accidents to determine the distance out to which a population density of 500 ppsm is sufficient to meet the requirements of 10 CFR 100.21(h) under the alternative approach described in SECY-20-0045.

As described in Section 2 of RG 1.183 for LWRs, non-LWR applicants must also provide a defensible technical basis for the source term used for the siting analysis and justification of an alternative to the existing guidance in Section C.5 of RG 4.7 (i.e., limited population density out to 20 miles from a reactor). The technical basis must be supported by sufficient experimental and empirical data, be verified and validated, be documented in a scrutable form that facilitates public review and must be peer reviewed by qualified subject matter experts. Guidance on specific elements of developing such a source term are provided in the following subsections. In the case that an applicant can show that the calculated offsite dose does not exceed 1 rem TEDE for the 30-day exposure period, the limiting population-related requirement may be that the site needs to be outside of any population center of approximately 25,000 persons.

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[11] This approach is provided to address non-LWRs using a containment-type barrier that encloses other barriers similar to the essentially leak-tight structures used for LWRs. The consideration of multiple barriers and event-specific mechanistic source terms are supported in the LMP methodology (See Item (1) Non-LWR Technology Applications Using Regulatory Guide 1.233). Hybrid approaches may be justified but are outside the scope of this guidance.

3.1 Establish Radionuclide Release(s) from the First Barrier

Recognition of the potential for a radiological source term – including activation of coolant/deposits, fission gas release, local failures (defects that are unlikely but credible over a sufficient sample size, channel blockages, etc.) and other relevant phenomena – is an important aspect of defense-in-depth to ensure that both prevention and mitigation of the full spectrum of credible adverse conditions that bear on public health and safety are considered.

In effect, a radionuclide release of some sort from the innermost barrier (typically the fuel) cannot be entirely precluded, and applicants should provide a safety analysis that demonstrates compliance with the requirements to justify a finding of reasonable assurance of adequate protection of public health and safety even under the worst credible accident conditions.

In many cases, a single analysis may adequately bound all other DBA analyses, and a single source term can be used for the siting analysis, which has generally been the case for nonpower reactor applications submitted to the NRC that have used a relatively conservative analysis. This does not preclude an applicant from providing multiple analyses for siting, the set of which bounds the plant behavior. Such an approach could allow reduced conservativism in the plant design by considering multiple source terms based on release mechanisms and plant conditions for different types of events while not fully adopting the methodology described in RG 1.233.

3.2 Perform an Event Assessment

When performing a comprehensive evaluation of postulated accidents, it is important to establish that what is analyzed is bounding. This can be done by performing a systematic assessment of the potential accidents and hazards and demonstrating that these events adequately envelope the facility design such that the analyses that are used are limiting. NRC proposed guidance for identifying events is provided in DG-1413 (Proposed RG 1.254), "Technology-Inclusive Identification of Licensing Events for Commercial Nuclear Plants." The International Atomic Energy Agency's (IAEA) Safety Guide includes the following information on a systematic search for hazards that should be conducted for nuclear reactor sites:

- Specific Safety Requirements No. SSR-2/1, "Safety of Nuclear Power Plants: Design" (Requirement 16: Postulated initiating events):

  > The design for the nuclear power plant shall apply a systematic approach to identifying a comprehensive set of postulated initiating events such that all foreseeable events with the potential for serious consequences and all foreseeable events with a significant frequency of occurrence are anticipated and are considered in the design.

An event assessment must be performed for the plant design basis to adequately justify the source term used for the siting analysis; however, there is no standard approach to identifying events for the assessment. Regardless of the approach, an applicant is required to provide an analysis and evaluation of the design and performance of SSCs during normal operations and transient conditions as well as assess the adequacy of SSCs to prevent and mitigate accidents. In addition, for the siting analysis, an applicant is required to provide an assessment and evaluation of the SSCs that bear significantly on the offsite dose evaluation factors. In performing this assessment, an applicant is required (e.g., 50.34(a)(1)(ii)(D)) to assume a fission product release from the core into the containment. Historically, this has been done through a prescribed source term representative of a significant core melt event with demonstrable containment leakage (i.e., TID-14844 or RG 1.183) which has been derived generically for large light water reactor technology. This conservative approach has allowed for some simplifications in the development and review of the fission product release because the prescribed source term developed by the NRC is used in lieu of detailed source term plant-specific analysis. This conservative source term is evaluated by the staff in concert with the rest of the information provided by the applicant to meet the sum of the regulatory requirements, including the fission product cleanup systems or features provided to mitigate the consequences of accidents.

For applicants whose design differs significantly from large light water reactor technology, difficulty arises because the guidance in RG 1.183 is not applicable to their design. In this case, the applicant could demonstrate, with design-specific source term analysis, compliance with the regulation (e.g., 50.34(a)(1)(ii)(D)), assuming a credible core damage event with subsequent release of appreciable quantities of fission products into a containment structure and meeting the applicable dose requirements. However, it is anticipated that non-LWR applicants and perhaps some LWR applicants (e.g., small modular reactors) differing significantly from current operating plants may determine the need to request an exemption from the regulation, using design-specific justifications for proposals to differ from the existing requirements related to assumptions for a major accident and the assessment of essentially leak-tight containments.

It is important to note that applicants should provide documentation of all anticipated hazards, including those excluded from consideration. If an event is precluded by some aspect of the design or an analytical assumption, that should be noted and justified.

3.3 Consideration of Uncertainty

The radiological releases proposed for use in siting analysis should provide margin to all design basis safety analyses. If using a single analysis or derived value, a justification should be provided for why this value adequately bounds the design basis. This justification can be substantially simpler the more conservative the siting analysis is.

The degree to which uncertainty needs to be considered depends on both the design and the analysis used to satisfy the regulatory requirements. A simpler design with relatively coarse assumptions might require less accounting for uncertainty at the cost of design margin (through use of more clearly conservative assumptions). Conversely, a finely refined analysis can be used to capture design margin (with an associated lower margin between the analysis and acceptance criteria) at the cost of quantifying the uncertainty and justifying how the analysis meets the applicable requirements. The need to provide assurances that safety functions will be fulfilled, and uncertainties are addressed is reflected in longstanding requirements such as 10 CFR 50.43(e), which requires demonstration of safety feature performance by analysis, appropriate test programs, experience, or a combination thereof.

If not captured directly by conservatism in the analyses, uncertainties should be established, where applicable, and quantified if possible. Subjectivity in establishing these uncertainties is ideally avoided through the use of quantitative tools that address uncertainties such as a PRA or consideration of experimental or dataset uncertainty, though use of a hazard assessment coupled with provisions of defense-in-depth (multiple means of satisfying a safety function to reduce or eliminate likelihood of phenomena) can provide satisfactory means of addressing phenomenological uncertainties.

3.4 Demonstrate Adequate Defense-in-Depth

Defense-in-depth involves using multiple independent and redundant layers of defense to compensate for potential failures so that no single layer, no matter how robust, is exclusively relied upon. More specifically, when evaluating defense-in-depth for the siting analysis, no single feature should be relied on for performance of a safety function.

This step is most difficult to quantify and is somewhat narrower than the full defense-in-depth concept referred to elsewhere (such as in IAEA guidance). For the purposes of the siting analysis, an accident is deemed to have occurred (so prevention and control of accident conditions are neglected once the release is established) and offsite mitigation is addressed through other regulations, as this regulatory requirement is directed at the radiological consequences at a set boundary.

When considered together, the population density alternative approach described in this white paper, and the other layers of defense-in-depth provided by compliance with the requirements on plant design and programmatic controls, demonstrate adequate overall defense-in-depth. Defense-in-depth is adequate if the overall redundancy and diversity among the plant's systems and barriers is sufficient, and the siting analysis demonstrates compliance with the requirements to justify a finding of reasonable assurance of adequate protection of public health and safety.

Conclusion

In order to comply with the requirements related to power reactor siting analysis, the analyses should account for the potential for radiological releases from the innermost or primary design barrier due to possible accident conditions. Historically, this release has been based on regulatory guidance developed for large LWR technology, which is not applicable to many of the advanced reactor designs being developed. Recent applications and approved methods have demonstrated that other means of analysis are acceptable. Due to the wide variety of designs and safety approaches, the spectrum of conditions and tradeoffs does not lend itself to prescriptive guidance similar to RG 1.183. Therefore, this white paper identifies a set of key attributes that should be addressed in the siting analysis, including establishing a release, performing a hazard assessment, considering uncertainty, and demonstrating adequate defense-in-depth. In addition, this white paper proposes three different approaches to estimating offsite consequences to inform the alternative population-related siting considerations for advanced reactors.