THIS PRELIMINARY PROPOSED RULE LANGUAGE AND ACCOMPANYING DISCUSSION IS BEING RELEASED TO SUPPORT INTERACTIONS WITH STAKEHOLDERS AND THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS). THIS LANGUAGE HAS NOT BEEN SUBJECT TO COMPLETE NRC MANAGEMENT OR LEGAL REVIEW, AND ITS CONTENTS SHOULD NOT BE INTERPRETED AS OFFICIAL AGENCY POSITIONS. THE NRC STAFF PLANS TO CONTINUE WORKING ON THE CONCEPTS AND DETAILS PROVIDED IN THIS DOCUMENT AND WILL CONTINUE TO PROVIDE OPPORTUNITIES FOR PUBLIC PARTICIPATION AS PART OF THE RULEMAKING ACTIVITIES.

This first iteration of key elements of an alternative design/licensing approach supporting more traditional methodologies (e.g., Deterministic selection of postulated initiating events, inclusion of single failure criterion) has been prepared below in the form of sections to be added to 10 CFR Part 50 for convenience. The final location of this alternative design/licensing approach will be determined at a later date. This new section would also apply as alternative technical requirements for applicants using the licensing processes in 10 CFR Part 52. The staff has found that this is a more efficient placement for the time being because Part 50 reflects the traditional methodologies such as those used in some international standards. This preliminary proposed rule language would provide a technology-inclusive alternative to the technical requirements specifically developed for light-water reactors (LWRs). However, the staff continues to evaluate where to place this alternative in relation to the more PRA--centered methodology in the preliminary proposed Part 53 subparts and the LWR--centered technical requirements in Part 50.

THE STAFF IS PRIMARILY SEEKING INSIGHTS REGARDING THE CONCEPTS IN THIS PRELIMINARY LANGUAGE AND SECONDARILY SEEKING INSIGHTS RELATED TO DETAILS SUCH AS NUMERICAL VALUES FOR VARIOUS CRITERIA OR FORMATTING ISSUES SUCH AS THE LOCATION OF THE REQUIREMENTS WITHIN TITLE 10 OF THE CODE OF FEDERAL REGULATIONS.

STAFF DISCUSSION OF TECHNOLOGY-INCLUSIVE ALTERNATIVE REQUIREMENTS FOR COMMERCIAL NUCLEAR PLANTS – PRELIMINARY PROPOSED RULE LANGUAGE

(October 2021)

Preliminary Language	Discussion
§ 50.200 Technology-inclusive alternative requirements for commercial nuclear plants	The following preliminary proposed rule language has been prepared for 10 CFR Part 50 to support the public release of this document. The staff would like to receive feedback on whether Part 50 is the appropriate location or if this proposed rule language should be incorporated into Part 53, and if so, how.
§ 50.210 Applicability Applicants submitting an application after **[ENTER EFFECTIVE DATE OF FINAL RULE]** for a commercial nuclear plant under Part 50 or Part 52 of this chapter may elect to adopt the following technology-	Consistent with the currently issued preliminary proposed Part 53 language, this approach could be used by any reactor applicant. Uses the Part 50/52 regulatory framework as a baseline. The applicability

inclusive requirements as an alternative to technical requirements in specified sections of Parts 50 and 52.	for some of the alternatives may be limited to non-LWRs to provide a technology-inclusive complement to existing LWR requirements.
§ 50.220 Definitions For the purpose of §§ 50.210 to 50.290: *Anticipated operational occurrences* mean those conditions of normal operation which are expected to occur one or more times during the life of the nuclear power unit and include but are not limited to loss of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser, and loss of all offsite power. *Commercial nuclear plant* means a utilization facility consisting of one or more nuclear reactors and associated co-located support facilities, which may include one or more reactor modules, [using nuclear fission, nuclear fusion, or accelerator-driven reactor technologies] that are used for producing power for commercial electric or other commercial purposes. The commercial nuclear plant includes the collection of sites, buildings, radionuclide sources, and structures, systems, and components (SSCs) for which a license is being sought after [**ENTER THE EFFECTIVE DATE OF THE FINAL RULE**]. *Non-light-water reactor* means a reactor that does not use water that does not contain deuterium as its coolant and neutron moderator. *Reactor coolant pressure boundary* has the definition specified in § 50.2. Where "*reactor coolant pressure boundary"* is used in the definition of *basic component* in § 50.2, any plant structure, system, component, or part thereof that is relied on to perform other safety related functions identified in §§ 50.250 and 50.280, such as cooling to maintain the integrity of required systems and barriers, should also be classified as a *basic component* in the context of § 50.55(e), as applicable. *Safety related SSCs* has the definition specified in § 50.2 for light water reactors. For non-light water reactors, an acceptable alternative is: those safety-related SSCs that are relied on in design basis events, as defined in § 50.49, to assure: 1) the capability to perform other safety functions as identified in §§ 50.250 and 50.280, such as cooling to maintain the integrity of required systems and barriers;	Currently only defined in 10 CFR Part 50 Appendix A. New definition replaces the "reactor coolant pressure boundary" portion of safety-related (below). The definition of "Safety related" is still under development, both in terms of the substance of the definition and the use of this term for SSC safety categorization in these sections of preliminary proposed language.

2) the capability to shut down the reactor and maintain it in a safe shutdown condition; or 3) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guideline exposures set forth in § 50.34(a)(1) or § 52.79 of this chapter, as applicable. All other terms in §§ 50.200 *et seq*. have the meaning set out in 10 CFR 50.2 and 10 CFR 52.1 or Section 11 of the Atomic Energy Act, as applicable.	
§ 50.230 Requirements Applicants must meet the following requirements: (a) *Single failure criterion.* (1) In using the provisions in §§ 50.210 through 50.290, the applicant must evaluate events assuming the worst single failure of active safety-related SSCs as part of the analysis and evaluations required to demonstrate the design adequately mitigates the consequences of AOOs and DBAs. (2) If an SSC is designated as passive, the designer must perform a comprehensive analysis and evaluation of test and/or operational data for the SSC to demonstrate that the reliability of the SSC is such that its failure probability is sufficiently low to justify not applying the single failure criterion [in (a)(1)]. (b) *Probabilistic Risk Assessment.* Applicants using the provisions of §§ 50.210 through 50.290 are required to develop a probabilistic risk assessment (PRA) and provide a description of the PRA and its results in their applications. (c) *Defense-in-depth*. Applicants need to demonstrate adequate defense -in- depth is provided in the design to prevent and mitigate AOOs and DBAs and to address beyond design basis events, including those potentially resulting in severe plant conditions.	These requirements are overarching elements that should be addressed by all applicants. These do not constitute new requirements; rather, they are identified separately here due to conflicts with existing language (single failure as part of the GDC) or for emphasis (use of PRA in a supporting, instead of leading, role). It is expected that any plant under this section will reflect through its design, construction, and operation an extremely low probability for accidents that could result in the release of significant quantities of radioactive fission products. Defense-in-depth is called out explicitly here as it is referenced in the analytical requirements below. The approach taken is consistent with Commission policy, and more information can be found in NUREG/KM-0009. Note that defense in depth may be addressed, at least in part, in existing requirements such as the general design criteria for LWRs (and available guidance for principal design criteria for non-LWRs).
§ 50.240 Principal design criteria	This section more directly addresses PDC and their role. Use of a deterministic approach is likely to rely

(a) In lieu of § 50.34(a)(3)(i) for construction permits and operating licenses, § 52.47(a)(3)(i) for design certifications, § 52.79(a)(4)(i) for combined licenses, § 52.137(a)(3)(i) for standard design approvals, and § 52.157(a) for manufacturing licenses, non-light water reactor applicants may provide alternatively developed principal design criteria (PDC) for the facility that do not follow the general design criteria (GDC) in 10 CFR Part 50, Appendix A. PDC establish the necessary design, fabrication, construction, testing, and performance requirements for SSCs important to safety. (b) Non-light water reactor applicants are required to provide principal design criteria using the GDC or other generally accepted consensus codes and standards to inform the development of the provided PDC. Sufficient information must be provided to provide reasonable assurance that the final design will conform to the design bases with adequate margin for safety.	more on top level design goals in the form of design criteria as opposed to a more integrated assessment. This language would allow for the use of the criteria in IAEA SSR 2/1 - the applicable standards include, but are not limited to: the existing GDC, Regulatory Guide (RG) 1.232, and IAEA SSR 2/1. Because of the existing rule language, the proposed text is applicable to non-LWRs only. NRC staff is considering how to allow LWRs to use already developed alternatives such as IAEA SSR 2/1 as part of this approach. Paragraph (b) is based on similar wording in § 50.34(a)(3)(iii).
§ 50.250 Anticipated operational occurrences and design basis accidents (a) Applicants are required under § 50.34 for construction permits and operating licenses, § 52.47 for design certifications, § 52.79 for combined licenses, § 52.137 for standard design approvals, and § 52.157 for manufacturing licenses to provide an analysis and evaluation of the design and performance of SSCs of the facility. (b)(1) In lieu of §§ 50.46, 50.34(a)(4), 52.47(a)(4), 52.79(a)(5), 52.137(a)(4), and 52.157(f)(1), applicants using the provisions of §§ 50.210 through 50.290 are required to identify postulated initiating events for anticipated operational occurrences and design basis accidents using a generally accepted, risk-informed approach for systematically evaluating engineered systems. (2) Those applicants are also required to define acceptance criteria for safety-related SSCs to provide reasonable assurance that their performance during anticipated operational occurrences and design basis accidents adequately mitigates the consequences of such events. (3) The analyses must demonstrate that there is reasonable assurance that fission products are retained within specified barriers for	These requirements are consistent in concept with existing regulations and international standards for these classes of events. Applicants should provide analysis for AOOs and DBAs, and features used to mitigate and prevent these events should be safety related.

each analyzed accident or otherwise that the dose to an individual located at the exclusion area boundary or low population zone outer boundary remains below the reference values specified elsewhere in this part. SSCs required to mitigate against anticipated operational occurrences and design basis accidents must be classified as safety-related. (4) Safety-related SSCs must be designed and located with due consideration to the environments and conditions associated with the internal and external hazards associated with design basis events.	
(5) Applicants must provide an analysis and evaluation of the design and performance of SSCs with the objective of assessing the risk to public health and safety resulting from operation of the facility and including determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility, and the adequacy of SSCs provided for the prevention of accidents and the mitigation of the consequences of accidents.	The requirement in (5) is based on 10 CFR 50.34(a)(4).
(6) Applicants may elect to perform a single or multiple bounding analyses and evaluations to demonstrate the design appropriately mitigates the consequences of accidents; in taking this approach, applicants must demonstrate that the bounding evaluation(s) adequately envelope conditions for the full range of anticipated operational occurrences and design basis accidents with sufficient margin. Such an evaluation may not be realistic in order to provide reasonable assurance that operation of the facility could not exceed the conditions imposed for the bounding evaluation(s). (c)(1) Applicants must identify limiting parameters that serve as safety acceptance criteria for the analyses of events and provide these values as part of the application. (2) For each change to or error discovered in an acceptable evaluation model or in the application of such a model that affects these safety acceptance criteria, the applicant or holder of a construction permit, operating license, combined license, or manufacturing license must report the nature of the change or error and its estimated effect on the safety analysis to the Commission at least annually as specified in §§ 50.4 or 52.3 of this chapter, as applicable. (3) If the change or error is significant, the applicant or licensee	The requirements in (6) provide an avenue for an applicant to provide bounding analyses for some or all of the analytical requirements for this part. To some extent, this is consistent with exiting practice – a single analysis to cover a category of event (e.g., overcooling) is often provided as part of a safety analysis. This would go a step further and allow for bounding analyses (potentially involving non-realistic assumptions) to be provided to cover larger portions of the AOO and DBA analytical space, provided the analysis envelopes the full range of conditions it is stated to bound. Further, this section incorporates requirements adapted from § 50.46(a)(3) - applicants are required to identify surrogate safety acceptance criteria, akin to peak cladding temperature for LWRs, and track and report errors in the analysis for these acceptance criteria. For LWRs, staff expects § 50.46 criteria will be the ones chosen.

must provide this report within 30 days of identification and include with the report a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with other requirements in §§ 50.210 through 50.290.	
§ 50.260 Beyond design basis events (a) In lieu of §§ 50.62, 50.63, 52.47(a)(15), 52.47(a)(16), 52.79(a)(9), 52.79(a)(42), 52.137(a)(15), 52.137(a)(16), 52.157(f)(5), and 52.157(f)(7) of this part, applicants using the provisions of §§ 50.210 through 50.290 must perform additional assessments and analyses to identify design features or programmatic controls for enhancing the plant's capabilities to withstand, without undue risk, events that are either more severe than design basis accidents or that involve additional failures. Events include unlikely but credible events that could lead to situations beyond those considered for DBAs, multiple credible failures (e.g., common cause failures in redundant SSCs) that prevent safety systems from performing their intended function, or credible failure sequences that are not assessed within the scope of DBAs but are mitigated by other plant SSCs outside the scope of the credited safety function of those SSCs. (b) Design features or programmatic controls should be developed to establish supplementary protections to mitigate against recognized BDBE initiators (e.g., reduction of risk from anticipated transients without scram, loss of all alternating current power) or complex accident sequences that may have substantial uncertainty associated with them, as well as other conditions specific to the design derived on the basis of engineering judgement, deterministic assessments, and probabilistic assessments. These features provide additional assurance of safety and defense-in-depth. (c) SSCs required to mitigate beyond design basis events need not be classified as safety related, but should have appropriate treatments identified to ensure these SSCs function as specified in the analyses required in (a) to mitigate these events. If an applicant elects to provide a bounding evaluation as described in § 50.250, that evaluation may be used to address any or all of the event(s) required as part of §§ 50.210 through 50.290 provided the bounding evaluation is demonstrated to envelope these beyond design basis events.	This section replaces SBO and ATWS regulations with a broader category of events, and draws on the international concept of defense-in-depth level 3b or 4a. It requires applicants to evaluate and provide prevention/mitigation features (non-safety related) against events more severe than DBAs based on operating experience, engineering judgement, and sequence-based assessment. These SSCs that are credited should have quality treatments in accordance with their function. The bounding analyses that may be used for AOO or DBA requirements may be expanded for use by applicants here. Special treatments include, but are not limited to availability controls (e.g., TS) or augmented quality.

§ 50.270 Severe accidents (a)(1)(i) In lieu of §§ 50.34(a)(1)(ii)(D), 52.47(a)(2)(iv), 52.47(a)(23), 52.79(a)(1)(vi), 52.79(a)(38), 52.137(a)(2)(iv), 52.137(a)(23), and 52.157(d) in this part, applicants using the provisions of §§ 50.210 through 50.290 are required to provide a description and analysis of design features deemed important to safety because they prevent or mitigate accidents that could progress beyond design basis accidents and events addressed by §§ 50.250 and 50.260. These events could include conditions not considered for design basis accidents, but that are considered in the overall design using best estimate methodology including consideration of uncertainties, in order to assess risk to the public health and safety. These events include those that would require analysis of design features for the prevention and mitigation of severe accidents.	These requirements replace existing severe accident requirements. This section borrows from the international concept of defense-in-depth level 4 or 4b. The requirements identified here are consistent with the Commission's severe accident policy statement (50 FR 32138) while tying together existing requirements with the commensurate analysis. For LWRs, such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products.
(ii) A light water reactor applicant must address how the design prevents and mitigates severe accidents based on conditions derived from operating experience and/or input from probabilistic risk assessments.	e.g., challenges to containment integrity caused by core-concrete interaction, steam explosion, high-pressure core melt ejection, hydrogen combustion, and containment bypass.
(iii) An applicant with a non-light-water reactor design must use engineering judgement and/or input from probabilistic risk assessments to identify what constitutes severe accident conditions for their specific design and describe the measures provided in the design for preventing or mitigating such accidents.	Severe accidents for non-LWRs are not defined to the same degree as LWRs; events evaluated in this section should involve some level of fuel or core damage, based on the event criteria outlined in this section.
(iv) Analyses of these accidents must show that the design demonstrates adequate defense-in-depth such that acceptable dose consequence criteria - including those in § 50.270(a)(2)(iv) below - are met even in circumstances with fuel or core damage or potential for large radiological releases from other sources in the facility. (2)(i) The applicant must provide information regarding safety features that will be engineered in the facility and any barriers that must be protected during various accidents to limit the release of radioactive material released to the environment. (ii) The applicant must perform an analysis and evaluation of the severe accidents that could lead to fission product release, using the expected barrier leak rate(s) and any fission product cleanup systems intended to mitigate the consequences of the accidents, together with	(iv) is consistent with the existing requirements related to the 25 rem and Part 100 requirements, which are based on a core damage event.

applicable site characteristics, including site meteorology, to evaluate the offsite radiological consequences. (iii) The accident-specific fission product release to be used in the analyses required by § 50.270(a)(2)(ii), must consist of a mechanistic source term that is based on physically based models of the facility response. (iv) Site characteristics must comply with Part 100 of this chapter.	
(v) The minimum acceptance criteria for the analysis required in this section are: (A) An individual located at any point on the boundary of the exclusion area for any 2 hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE), and (B) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem TEDE. (vi) Analyses that show that the necessary systems and barriers remain effective during postulated accidents may be used as a surrogate for offsite dose calculations required in § 50.270(a)(2)(ii) for postulated accidents. (vii) Applicants electing not to use mechanistic source terms to evaluate postulated accidents may use a bounding-type assessment assuming severe plant conditions and reliance on a given barrier such as a containment structure.	Minimum is a reference to the fact that applicants may elect to use more stringent acceptance criteria (which would then replace these) in order to achieve additional flexibilities offered by Part 53 provisions referenced below. These criteria also apply to DBAs, consistent with existing requirements. NRC staff expects that the severe accident conditions will bound those conditions.
(b) As part of the overall safety design philosophy, the applicant must demonstrate defense-in-depth such that no plausible scenario leads to dose consequences beyond the acceptance criteria identified in the § 50.270(a)(2)(iv). In performing the analyses required in this section, applicants are not required to evaluate scenarios that are not physically possible or can be shown to occur at a sufficiently low frequency with a high degree of confidence such that consideration of these events can be excluded as part of the residual risk of the facility.	Requires applicants consider defense-in-depth (no reliance on a single SSC/barrier) and mitigate against more severe potential scenarios. Provides avenues for crediting barrier mitigation and excluding some events, similar to international “practical elimination” concept. Staff expects there would be a frequency threshold for this exclusion for applicants leveraging a PRA. The “residual risk” portion is subject to change or further clarification.

§ 50.280 Functional containment (a) As an alternative to § 50.54(o), the requirement that the containment remains intact in § 50.150(a)(i), the containment portion of §§ 50.155(b)(1)(i), and 52.79(a)(12), non-LWR applicants may elect to provide a functional containment; that is, may designate a set of barriers taken together that effectively limit the physical transport and release of radionuclides to the environment across the full spectrum of events discussed above. As part of the approach under §§ 50.210 through 50.290, aspects of SSCs designated as part of the functional containment (and those that support these SSCs) used in the analyses of DBAs must be classified as safety related. (b) If SSCs designated as part of the functional containment are relied on to mitigate events in § 50.260, the applicant must identify appropriate treatments such that these SSCs function as assumed in their role as part of the functional containment. To support defense-in-depth, acceptance criteria (including the dose consequence criteria) related to the performance of these SSCs must be met without exclusive reliance on any single element of the design.	These requirements replace containment-related regulatory requirements. They establish what constitutes a functional containment and makes functional containment SSC qualification commensurate with the purpose of the component (safety related for AOOs/DBAs, special treatment for "BDBEs"). Paragraph (b) reflects that the SSCs making up the functional containment should be classified according to their role in addressing AOOs, DBAs, beyond-design basis accidents, or severe accidents.
§ 50.290 Design requirements Applicants must apply the following provisions of this section, as applicable: *(a) Technical specifications* – In lieu of the four criteria for limiting conditions for operation (LCO) listed in § 50.36(c)(2)(ii), applicants may provide LCOs for § 50.36(c)(2)(ii)(B) and (C) only, provided these criteria identify appropriate requirements on systems that perform other safety functions such as cooling to maintain the integrity of required systems and barriers. (b) Provided applicants comply with §§ 50.220 through 50.290, applicants using the provisions of this section need not comply with the following regulations: … [to be revised as needed] (c) *Reserved*	Depending on how this proposed rule language develops, this section may be folded into § 50.230 and/or portions of § 50.230 may be relocated here. LCO criteria (A) relates to reactor coolant pressure boundary; LCO criteria (D) is based on PRA and operating experience. This provision would remove consideration of those criteria from being required, provided barrier requirements are captured. This serves to catch additional Part 50 regulations that conflict with this section and could change as the Part 53 provisions are added.
	Areas from Part 53 being explored for use in this alternative framework– In utilizing the provisions of §§ 50.200 et seq., applicants may choose to use the following regulations:

	Special treatment – In addressing the requirements associated with paragraph (e) of this section, applicants are required to identify appropriate treatments for SSCs relied on to mitigate these events. In identifying these treatments, applicants may use the framework set forth in § 53.YYY. *Siting considerations* – In lieu of [appropriate set of 50/52 siting requirements], applicants may apply § 53.5XX to determine site boundary areas and populations considerations. *Emergency preparedness requirements* – In lieu of §§ 50.54(q), 50.54(t), [other appropriate 50/52 EP requirements], applicants may apply § 53.5XX to determine emergency preparedness requirements. *Security requirements* – As an alternative to the requirements set forth in §§ 50.34(c), 52.79(a)(35), and [other appropriate requirements as applicable], applicants may apply § 73.YY in lieu of the requirements necessary to satisfy the cited physical security requirements. (additional references to Part 53 – here or elsewhere)