

DISCUSSION OF PROPOSED 10 CFR 50.46a

Overview of the Proposed Risked Informed Rule

The proposed rulemaking, “Risk-Informed Redefinition of Large Break LOCA ECCS Requirements” at Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46a, if promulgated, will be a risk-informed alternative to the current emergency core cooling system (ECCS) rule at 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors.” This risk-informed rulemaking is intended to determine what relaxations in ECCS analyses are appropriate. Based on the new proposed risk-informed ECCS rule, 10 CFR 50.46a, licensees would still be required to consider the impacts of larger breaks, albeit with more realistic methods. The rule significantly reduces the loss-of-coolant accident (LOCA) break area that must be treated as a design-basis accident (DBA). Under the proposed 10 CFR 50.46a, the largest DBA break area is called the “transition break size (TBS).” For a pressurized-water reactor (PWR), the TBS is defined as a break area equal to the cross-sectional flow area of the inside diameter of the largest piping attached to the reactor coolant system. The largest main coolant pipes in PWRs are on the order of 30–40 inches in diameter. The inside diameter of the largest attached pipe at any PWR is less than 14 inches. Further, under the proposed 10 CFR 50.46a rule, breaks in the main coolant loops would not need to be considered double-ended breaks. As a result, for the main loop piping, this change could reduce the largest break area that must be analyzed as a design-basis LOCA by more than an order of magnitude.

The proposed rule would classify LOCAs smaller than the TBS as DBAs, and LOCAs larger than the TBS as beyond-design-basis accidents. In the proposed 10 CFR 50.46a, design-basis LOCAs (LOCAs smaller than, or equal to, the TBS) would be analyzed using the same requirements included in 10 CFR 50.46 to demonstrate the adequacy of the ECCS. The analysis of LOCAs smaller than the TBS would be required to include a coincident loss of offsite power, worst single failure, and credit only for safety-grade equipment. The staff of the U.S. Nuclear Regulatory Commission (NRC) reviews and approves DBA analysis methods. Approval of the methods is based on a rigorous justification of models, assumptions, and inputs. Design-basis analysis methods typically include a clearly conservative bias for parameters or models for which a less rigorous justification is provided, even when the “best-estimate” option is exercised.

Under the proposed 10 CFR 50.46a, LOCAs with a break area larger than the TBS (beyond-design-basis LOCAs) would still require mitigation. However, because these events are expected to be much less likely to occur, the analysis assumptions and the rigor associated with the justification of models, assumptions, and inputs would be reduced relative to design-basis events. For the beyond-design-basis LOCAs, credit would be allowed for offsite power and for use of nonsafety equipment. No coincident random failure would be required. Although licensees would still need to provide sufficient justification to ensure that models, parameters, and assumptions are representative of actual plant operation, greater uncertainty in the justification would be permissible given the low likelihood of the larger LOCAs. Therefore, the use of reasonably justified unbiased parameters would be acceptable.

Implications of the Proposed Rule for GSI-191, If Promulgated and Adopted by Licensees

One of the most significant aspects for evaluations related to Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," involves the debris source term that must be assumed for strainer headloss testing and for evaluating in-vessel effects. The debris source term is uncertain because of a number of factors, the most important of which are the jet impingement zone of influence (ZOI), debris characteristics, and debris transport to the sump strainers. As such, the primary sump implementation issue associated with the proposed rule is the establishment of an adequate level of rigor for justification of unbiased parameters in the debris source term determinations for beyond-design-basis accidents. Based on the current state of knowledge, the staff believes that some relaxations in the source term are possible. However, unless proposed industry testing of ZOI and settling yields favorable results, many or most of the remaining plants will likely require additional strainer testing, modifications, or both, to achieve closure because of the very high fiber loads at these plants. Additionally, implementation of the proposed rule would require separate analyses for breaks above and below the TBS, using different assumptions, leading to the potential need for separate demonstration tests of adequate strainer performance. Despite these additional complexities, implementation of the proposed rule for GSI-191 could benefit licensees by reducing the scope of potential modifications at some remaining plants to demonstrate adequate strainer performance for the largest LOCAs, which typically have the potential to generate the most debris and are usually the limiting breaks in licensees' sump performance analyses.

If the Commission adopts 10 CFR 50.46a, the rule would provide licensees more options and potentially lessen the burden for closing out GSI-191 issues. The less conservative assumptions required for assessment of beyond-design-basis events could result in a reduced debris source term relative to current analyses for larger LOCAs. A reduced source term could in turn result in less need for testing or insulation removal. In addition, licensees might wish to augment existing strainers with active components or credit existing nonsafety features rather than remove insulation. For example, several licensees have noted the existing ability to backflush strainers, but have indicated concerns with regard to licensing that capability. The ability to use nonsafety equipment, offsite power, and nonredundant systems for LOCAs larger than the TBS could increase the feasibility of crediting features such as backflushing.

The flexibility afforded by 10 CFR 50.46a could reduce the burden associated with equipment modifications, reanalysis, or testing programs needed to address pump net positive suction head (NPSH) concerns and in-vessel effects for breaks larger than the TBS. However, adoption of 10 CFR 50.46a would not be expected to provide an "analysis only" solution for all issues, and the extent of benefit would depend on what factors are limiting for a given plant. Benefits from use of more realistic analyses will also depend on the staff and industry establishing viable positions for beyond-design-basis accidents in challenging areas, such as ZOI and debris settlement. The potential benefits for addressing in-vessel effects might also be limited because the amount of fiber bypass that can be problematic for in-vessel effects is apparently relatively small and may still be generated by LOCAs smaller than the TBS, especially in plants with large quantities of fibrous insulation.

10 CFR 50.46a Rulemaking Schedule and Currently Proposed Adoption Requirements

The proposed rule has been under consideration for several years, has been vetted through several public meetings with stakeholders, and has been published for formal public comment twice. The technical basis is therefore well established. A final rule is due to the Commission for approval in December of this year.

Assuming that the Commission approves the rule, licensees could choose to adopt it immediately. A licensee could choose to adopt 10 CFR 50.46a simply for the purpose of resolving GSI-191 without making any other changes to the plant. In such a case, a licensee would need to do the following based on the current language in the proposed rule, which is subject to change before final approval:

1. Show the applicability of the supporting technical basis for the rule to its plant. This involves demonstrating that the assumptions of the expert elicitation study (NUREG-1829, "Estimating Loss-of-Coolant Accident (LOCA) Frequencies through the Elicitation Process," issued April 2008) are consistent with the plant design and operation. A draft regulatory guide is available for that purpose. Licensees that have been approved or have applied for license renewal need only to confirm that their aging management programs are consistent with license renewal plans or commitments.
2. Show the applicability of the staff's seismic study supporting the rule (NUREG-1903, "Seismic Considerations for the Transition Break Size," issued February 2008). A licensee would have to perform a plant-specific study if applicability is not demonstrated. However, a draft regulatory guide has been prepared for this purpose and additional evaluation will only be required if a plant cannot demonstrate that the NUREG-1903 study is representative of the plant conditions.
3. Perform a risk-informed evaluation of any proposed changes to the plant's licensing basis in accordance with the guidance of Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis." Thus, licensees would need to submit changes made to support GSI-191 resolution in a risk-informed license amendment submittal.
4. Use plant technical specifications to identify nonsafety equipment that is credited for demonstrating compliance with the ECCS acceptance criteria for LOCAs above the TBS. Additionally, establish and monitor reliability and availability goals for credited nonsafety systems.
5. Every 4 years, revisit changes made to the plant to confirm that the technical basis for 10 CFR 50.46a (steps (1), (2), and (3)) has not been invalidated.

Parts of the ECCS analyses that address the short-term LOCA response (before sump recirculation) would remain valid since existing models and analysis all meet the criteria of 10 CFR 50.46a. Thus, there would be no need to reanalyze the short-term ECCS response or make any changes to existing approved models unless a licensee wishes to make other changes (i.e., changes not related to sump recirculation) that are "enabled" by 10 CFR 50.46a. Only changes that would be enabled by 10 CFR 50.46a would require a risk-informed

evaluation. "Enabled" changes are changes that would satisfy the requirements of 10 CFR 50.46a, but would not satisfy the requirements of 10 CFR 50.46. If a change can be justified on the basis of an existing 10 CFR 50.46 analysis, then a risk-informed review would not be required, even if a licensee has adopted 10 CFR 50.46a. Thus, unless a licensee chooses to take advantage of additional (other than sump recirculation) enabled changes, there would be no need for new ECCS evaluation models or additional risk-informed submittals. The licensee could continue to use already-approved ECCS models.

Comparison of the Proposed 10 CFR 50.46a to Section 6, A Limited Risk-Informed Approach Currently Available to Licensees in the 2004 Safety Evaluation for NEI 04-07

The Nuclear Energy Institute (NEI) guidance report (NEI 04-07) entitled, "Pressurized Water Reactor Sump Performance Methodology," and the accompanying NRC safety evaluation (SE) (Agencywide Documents Access and Management System Accession No. ML043280007) included a risk-informed alternate methodology in Section 6. The risk-informed alternative included the use of more realistic mechanistic assumptions for the larger, less risk-significant LOCAs, and risk calculations as necessary in the event that plant-specific changes requiring exemptions from 10 CFR 50.46, single-failure, and safety-related requirements were required. Although differences exist, the risk-informed Section 6 methodology was intended to be consistent with the proposed 10 CFR 50.46a rule at the time NEI 04-07 was issued. The 2004 staff SE on NEI 04-07 endorsed, with limitations and conditions, the method described in Section 6 of NEI 04-07. Section 6 divided the break sizes into two regions with a dividing size called an alternate break size consistent with the TBS in the proposed 10 CFR 50.46a rule. Section 6 allows a reduction in conservatism for certain design-basis assumptions for analyzing strainer performance for LOCAs on piping larger than the TBS (a nominal 14-inch diameter at many PWRs). Section 6 also allows consideration of modifications that could not be considered in a design basis analysis such as reliance on a non-safety system. Depending on the reduced level of conservatism and/or the proposed modifications, a risk-informed evaluation and exemptions from the requirements might be proposed. Based on reviews of licensees' responses to Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," dated September 13, 2004, the staff has observed that few licensees (e.g., 2-3 plants) have explored the risk-informed alternate methodology described in Section 6 of the staff's SE on NEI 04-07, and no licensee has implemented the options that require risk calculations.

The staff has not solicited systematic input from licensees to discern the reasons that the risk-informed Section 6 approach was not implemented. However, the staff has received anecdotal feedback from the industry. The most notable feedback was that the staff has been unwilling to accept more realistic assessments in critical debris source term areas (e.g., ZOI and debris transport). The staff believes that more realistic assessments in these areas sufficient to support an exemption request from 10 CFR 50.46 would not be justifiable because realistic models of the phenomena in these areas do not exist and are beyond the state of the art. Significant progress has been made in understanding sump phenomena since Section 6 was written, and the staff would incorporate this improved state of knowledge in new 10 CFR 50.46a implementing guidance. But important aspects of modeling the debris source term are still beyond the current state of the art. As discussed earlier, the proposed 10 CFR 50.46a rule would potentially provide some additional flexibility in determining more realistic treatment for beyond-design-basis breaks than that which currently exists under 10 CFR 50.46. However,

while not yet determined, the staff does not envision major changes to the current Section 6 approaches absent significant additional research or testing. The industry currently plans to perform additional testing in the areas of ZOI and settling. These activities may justify significant changes to realistic assessment of debris source term for beyond-design-basis breaks. However, as these tests have not yet been performed, their outcome is uncertain. Additionally, the staff has not accepted past testing in these areas for reasons such as design errors and unjustified test assumptions.

The staff has received other anecdotal feedback on why licensees have not implemented the Section 6 method. This feedback, in addition to contributing factors identified by the staff, are provided in the following table, along with a future outlook assessment of these factors under the proposed 10 CFR 50.46a rule in its current form.

Past Factors Contributing to Licensees' Not Implementing Risk-Informed Alternate Approach to GSI-191 Resolution	Future Outlook
Implementation of many significant provisions of the Section 6 methodology would require an exemption to 10 CFR 50.46 or other regulations (e.g., crediting nonsafety systems with LOCA mitigation or not considering a single failure in the analysis for breaks on piping larger than 14 inches).	Under the proposed 10 CFR 50.46a rule, licensees that adopt the rule for GSI-191 will not need exemptions for breaks above the TBS because these allowances are in the new rule.
Implementation of some provisions of the Section 6 methodology could require plant-specific license amendments.	Under the proposed 10 CFR 50.46a rule, licensees that adopt the rule for GSI-191 would need to submit license amendment requests for risk-informed licensing basis changes.
The existing Section 6 methodology is not comprehensive in providing guidance with reduced conservatism in many areas of the analysis, including ZOI, debris transport, headloss, and chemical effects. This is because sufficiently realistic models for risk-informed treatment of these areas that lead to sump clogging do not currently exist and have not been developed by the industry or NRC staff.	Under the proposed 10 CFR 50.46a rule, based on their low likelihood, breaks larger than the TBS would become beyond-design-basis breaks. Existing guidance in Section 6 could be the starting point for new 10 CFR 50.46a implementing guidance to provide reduced conservatism for other areas of the evaluation. However, large changes in current models for some phenomena will be very challenging without significant additional research or testing.

Licensees implementing the Section 6 methodology need to perform analyses for breaks above and below 14 inches in diameter. Additionally, testing to justify that risk-informed mitigation methods are reliable may be necessary. For example, a licensee may need to reference or perform testing to show that a nonsafety system credited for unclogging a clogged strainer can perform its function.	Under the proposed 10 CFR 50.46a rule, there would be no change.
Licensees initially expected to be able to address the strainer performance issue without needing to resort to risk-informed approaches. They also believed that the new strainer designs would have a large margin to accommodate potential future challenges to strainer performance.	Licensees have recognized that significant uncertainties associated with the strainer performance issue make it difficult to demonstrate adequate strainer performance with large margins using design-basis analysis methods and are expected to be more amenable to alternate resolution approaches.

Future Outlook for Section 6 after the Proposed 10 CFR 50.46a Is Approved or Disapproved

The original intent of the Section 6 guidance was to achieve consistency with the expected outcome of the 10 CFR 50.46a rulemaking process based on the form of the proposed rule in 2004, when the staff issued its SE on NEI 04-07. As such, assuming the Commission approves 10 CFR 50.46a, Section 6 will be used as a starting point for new implementing guidance for GSI-191 which will incorporate more realistic methods and will be made consistent with the final 10 CFR 50.46a rule. The staff does not intend to review requests to use Section 6 evaluations if GSI-191 specific implementing guidance for 10 CFR 50.46a is endorsed because 10 CFR 50.46a, if approved, will be the NRC's processes to risk inform the ECCS requirements. In this event, a risk-informed resolution to GSI-191 should be performed according to these requirements. As such, new implementing guidance would likely supersede the existing Section 6 approach.

Should the proposed 10 CFR 50.46a rule not be issued, the staff would need to consider the implications of the Commission's decision on the existing Section 6 approach. It might be appropriate to enhance or revise the section or to eliminate the approach entirely, depending on the Commission's views on the subject.