

White Paper Industry Proposal on Option 3, LOCA Redefinition

1. Introduction

In its Staff Requirements Memorandum (SRM) dated March 31, 2003, the Commission directed NRC staff to complete the technical basis supporting the large break Loss of Coolant Accident (LB-LOCA) break size redefinition and to provide proposed rule changes to the Commission by March 31, 2004. While the SRM provides guidance on considerations toward development of proposed rule changes and supporting guidance, significant latitude is provided NRC staff in completing the task.

The SRM also directs the staff to seek early public and stakeholder comments on the SRM proposals. On June 9, 2003 and July 24, 2003, NRC staff held public meetings with NEI, industry representatives and other interested stakeholders to solicit industry's input and to identify issues that require resolution for rulemaking on risk-informed changes to 10 CFR 50.46. Future meetings are planned to continue this dialogue.

This white paper was developed and is being utilized as a means to identify key areas of interest and to facilitate discussions through the proposal of possible means of resolution.

2. Summary

This white paper describes industry proposals for redefinition of the design basis large break LOCA, taking into consideration the direction provided by the Nuclear Regulatory Commission in its March 31 SRM and discussions from public meetings conducted on June 9 and July 24. These proposals are intended to support ongoing discussions between industry and NRC staff on the full range of topics necessary to support risk-informed changes to 10 CFR 50.46.

A previous revision to the white paper (Draft 2) was presented and discussed during the July 24 meeting between NRC and Industry. A main point in these discussions was identification by NRC staff of the need for key areas of the March 31 SRM to be reflected in the rule language. The suggestion was made that a separate section of the rule could be developed to provide needed detail. This separate section could then be used to support other risk-informed rule changes.

The current white paper revision (Draft 4) reflects the July 24 meeting discussions and proposes the addition of a new section to 10 CFR Part 50. This new section, tentatively titled "Risk-Informed Technical Requirements" would specify requirements for voluntary implementation of risk-informed technical requirements identified in other parts of 10 CFR Part 50. The proposed section has a subsection specifically addressing alternative break size definition. A separate subsection would be added to address LOOP-LOCA

separation. Using experience gained from these applications a third subsection could be added in the future to address a broader risk-informed process for addressing Part 50 technical requirements.

3. NEI Proposal for LBLOCA Redefinition

Upon consideration of Commission guidance contained in the SRM and discussions with NRC staff, NEI offers the following proposal for rule change to enable development and implementation of an alternative maximum LB-LOCA break size. The proposed changes affect 10 CFR 50.46, paragraph (c), Appendix A and Appendix K to Part 50 by adding the words:

...or up to an alternative break size meeting the requirements of section 50.xx(c).

A new section to 10 CFR Part 50, 'Part 50.xx', would be added to provide a necessary level of specificity to risk-informed changes to 10 CFR Part 50 technical requirements. This new section to Part 50 (Table 1) would initially contain four subsections:

- (a) Definitions
- (b) Applicability of Risk Informed Technical Requirements
- (c) Alternative Break Size Definition
- (d) Loss of Offsite Power Coincident with Loss of Coolant Accident

Subsections (a) and (b) provide necessary guidance on terminology used in the section and on applicability of the voluntary requirements. Subsection (c) provides guidance on the definition and implementation of an alternative break size for LOCA analyses and would be referenced by 10 CFR 50.46, Appendix A and Appendix K. Similarly, subsection (d) would include guidance on alternatives to current requirements that call for a loss of offsite power to be assumed coincident with a loss of coolant accident (specific wording not offered in this white paper).

A fifth subsection (e) could be added in the future to address, in a more general sense, the requirements for risk-informed changes to 10 CFR Part 50 technical requirements. This section would be developed after experience has been gained on the specific voluntary alternatives addressed in subsections (c) and (d).

As with the earlier proposals, this proposal maintains the current maximum break size based on double-ended guillotine break of the largest pipe in the reactor coolant system, and offers an option for a voluntary risk-informed alternative break size. The alternative break size would be identified and implemented into a plant's design basis by a risk-informed process, subsection (c)(i).

Break Size Redefinition

Subsection (c)(ii) identifies requirements for the risk-informed process used to identify the plant-specific alternative break size. This process would demonstrate, with reasonable confidence, that the combined contributions to risk from break sizes greater than the alternative break size are small. The risk assessment supporting the evaluation would need to address the risk contribution from all plant operating modes and would need to address internal and external initiating events. The language used in the proposed 50.xx is similar to that proposed for 50.69, and requires a risk assessment that includes all plant modes and all plant initiating events. The proposed language does not require a PRA that includes all plant modes and all plant initiating events.

Plant Change Process Following Redefinition

Subsection (c)(iii) identifies requirements for assessment of plant changes following incorporation of the alternative break size into a plant's design basis. This process is intended to apply to all plant changes and is not specifically limited to changes that specifically take advantage of the redefinition of the design basis LOCA break size.

The change process would be required to include risk assessment evaluations that show, with reasonable confidence, that sufficient safety margins are maintained and that any potential increases in core damage frequency and large early release frequency are small.

Change Monitoring

Subsection (c)(iv) identifies a requirement to monitor the impact of plant changes, operating practices and applicable plant and industry experience to assure that the basis upon which the alternative break size was based, remains valid.

Table 1

50.xx Risk Informed Technical Requirements

(a) Definitions

- (i) Alternative Break Size – Maximum large break Loss of Coolant Accident break size established by a risk-informed process that is applicable to the requirements of Sections 50.46, Appendix A and Appendix K to Part 50, in lieu of using the largest pipe in the reactor coolant system.

(b) Applicability of Risk Informed Technical Requirements

- (i) A holder of a license to operate a light water reactor (LWR) nuclear power plant under Sec. 50.21(b) or 50.22, a holder of a renewed LWR license under Part 54 of this chapter; a person seeking a design certification under Part 52 of this chapter, or an applicant for a LWR license under Sec. 50.22 or under Part 52, may voluntarily comply with the requirements in this section as an alternative to compliance with the technical requirements that cite this section.

(c) Alternative Break Size Definition

- (i) A licensee may voluntarily identify an alternative break size using a risk-informed process for use in design analyses subject to the limitations identified in this section.
- (ii) The risk-informed process used to support identification of an alternative break size must include evaluations that provide reasonable confidence that the contribution to risk from break sizes greater than the alternative break size are small. This process shall address initiating events (internal and external), SSCs, and plant operating modes, including those not modeled in the plant-specific PRA. All aspects of the integrated, systematic process used to assess the risk contribution of break sizes greater than the alternative break size must reasonably reflect the current plant configuration and operating practices, and applicable plant and industry operating experience.
- (iii) Following the incorporation of the alternative break size into a plant design basis, changes to plant hardware or operation shall be supported by a process that:
 - A. Includes evaluations that provide reasonable confidence that sufficient safety margins are maintained and that any potential increases in core damage frequency (CDF) and large early release frequency (LERF) are small.
 - B. Determines the risk impact of the change using an integrated, systematic process for addressing initiating events (internal and external), SSCs, and plant operating modes, including those not modeled in the plant-specific PRA. The functions to be considered include design bases functions and functions credited for mitigation and prevention of severe accidents. All aspects of the integrated, systematic process used to assess the risk impact of the change must reasonably reflect the current plant configuration and operating practices, and applicable plant and industry operating experience.
 - C. Maintains the defense-in-depth philosophy.
- (iv) The licensee shall monitor the combined impact of plant changes, operating practices, and applicable plant and industry operating experience to assure that the basis for identification of an alternative break size remains valid.

(d) Loss of Offsite Power Coincident with Loss of Coolant Accident

(e) Requirements for Risk-Informed changes to Technical Requirements (later)

Use of Reg. Guide 1.174 as Supporting Guidance

The language offered in the proposed section 50.xx is fully consistent with current risk-informed guidance. The intention of the 50.xx language is that it would enable the use of established risk metrics and review guidance used to support a broad range of risk-informed decisions. Regulatory guidance developed to support risk-informed decisions (e.g., Reg. Guide 1.174) would provide the necessary implementation guidance to support review and assessment of proposed plant changes. Consistent with other risk-informed regulatory activities, application specific guidance would be developed to expand upon the framework of Reg. Guide 1.174 and address items that are unique to LB-LOCA redefinition.

Use of the Reg. Guide 1.174 approach and structure would provide a defensible connection with other risk-informed regulatory changes and would ensure a necessary level of consistency for a range of applications.

The evaluation performed to support definition of an alternative break size would demonstrate that break sizes above the alternative maximum break size are non-significant contributors to risk using appropriate risk-informed acceptance guidelines and risk metrics. A similar process would be used to evaluate the singular and combined effects of plant changes following implementation of an alternative break size.

The guidance of Reg. Guide 1.174 provides a solid basis for addressing the key principles of risk-informed decision-making. These principles, as stated in RG 1.174 are:

1. The proposed change meets current regulations unless it is explicitly related to a requested exemption or rule change
2. The proposed change is consistent with defense-in-depth philosophy
3. The proposed change maintains sufficient safety margins
4. When proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement
5. The impact of the proposed change should be monitored using performance measurement strategies

Risk Assessment Scope and Level of Detail

Requirements applicable to risk assessment scope and level of detail are identified in sections 50.xx(c)(ii) and 50.xx(c)(iii); addressing requirements for the initial definition of the alternative break size and evaluation of plant changes following implementation of the alternative break size.

The proposed language in section 50.xx calls for the risk assessment to address all initiating events (internal and external), SSCs and plant modes. This language is consistent with proposed rule language in 10CFR50.69 and is intended to provide latitude necessary to address a wide range of plant changes following implementation of the alternative break size. The scope, level of detail

and technical acceptability of the risk assessment would be established commensurate with the proposed change.

We anticipate and support the development of guidance that would outline the expectations and necessary process steps for performing a risk assessment of proposed design changes. This process could be modeled after the NEI-00-04 categorization process. The NEI-00-04 process outlines a flexible approach for addressing all initiating events (internal and external) and plant modes. It acknowledges that full scope/all mode PRAs do not currently exist and allows for the use of existing screening tools, such as FIVE, SMA. These screening tools would be applied in a conservative manner and incorporated as part of the broader risk assessment of proposed changes.

Defense in Depth

As proposed in section 50.xx(c)(iii)(C):

Changes to hardware or operation resulting from implementation of the alternative break size must be supported by a process that maintains the defense-in-depth philosophy.

Consistent with Reg. Guide 1.174, the evaluation supporting any plant changes would need to show consistency with the defense-in-depth philosophy by demonstrating:

- A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation
- Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided
- System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers)
- Defenses against potential common cause failures are preserved, and the potential for the introduction of new common cause failure mechanisms is assessed.
- Independence of barriers is not degraded
- Defenses against human error are preserved.
- The intent of the General Design Criteria in Appendix A to 10 CFR Part 50 is maintained.

Safety Margins

While more properly considered a subset of Defense-in-Depth, the need to maintain sufficient safety margins is addressed separately in the Integrated Decision Making process outlined in Reg. Guide 1.174. Safety margins are applied to the design, analysis and operation of nuclear systems and account for parameter, modeling, and completeness uncertainties.

Regulatory Guide 1.174 outlines two acceptance guidelines for maintaining sufficient safety margins:

- Codes and standards or their alternatives approved for use by the NRC are met, and
- Safety analysis acceptance criteria in the licensing basis (e.g., updated FSAR, supporting analyses) are met, or proposed revisions provide sufficient margin to account for analysis and data uncertainty.

The determination of sufficient safety margins for any proposed changes following a redefinition of the design basis LBLOCA would involve a determination that the safety analysis acceptance criteria are met for the revised licensing basis and would be performed as part of the “50.59” review associated with the change. This could involve a re-analysis (incorporating the proposed change) for significant changes or a qualitative determination that changes have little or no impact on the conduct of or results obtained from licensing basis analyses.

Small Change In Risk

As proposed in section 50.xx, there are three separate assessments of risk impact associated with the “Alternative Break Size Definition” process. The initial assessment of risk impact is identified in subsection (c)(ii) and covers the assessment necessary to define the alternative break size:

The risk-informed process used to support identification of an alternative break size must include evaluations that provide reasonable confidence that the contribution to risk from break sizes greater than the alternative break size are small. This process shall address initiating events (internal and external), SSCs, and plant operating modes, including those not modeled in the plant-specific PRA.

Several alternatives are available for performing this assessment and determining the alternative break size. One alternative is to quantify the risk associated with break sizes greater than the alternative break size and apply a risk metric that includes both CDF and LERF impact (NEI White Paper Draft 2). A second alternative is to apply a metric that is related to the frequency of breaks greater than the alternative break size. The basis for any “frequency-based” metric would likely be supported by an assessment of risk and could be performed in manner to minimize the need for plant-specific quantification of risk. Plant-specific application of an alternative break size (developed by NRC RES) would then involve either a direct application of the bounding alternative break size or development of a plant-specific justification for a less restrictive alternative.

Following redefinition of the design basis break size, any proposed plant changes would invoke two separate assessments:

Section 50.xx(c)(iii) identifies the requirement to perform evaluations to assure for any proposed change that safety margins are maintained, potential increases in CDF and LERF are small and that defense-in-depth are maintained. This assessment would follow and utilize the principles of Reg.

Guide 1.174 and would be performed for any plant changes following incorporation of the alternative break size into a plant design basis.

In addition to, or as an integral part of this evaluation, there is a proposed requirement to confirm the continued applicability of the original basis for alternative break size definition:

50.xx(c)(iv): *The licensee shall monitor the combined impact of plant changes, operating practices, and applicable plant and industry operating experience to assure that the basis for identification of an alternative break size remains valid.*

Use of Best-Estimate Codes and Models

Regarding use of Best-Estimate Codes and Models the SRM states "...licensees who seek the benefit of the changes that redefine the design basis LBLOCA requirements should be required to use best-estimate codes."

Appendix K methods remain the LBLOCA analysis method of record for the majority of operating plants. Use of best-estimate codes and methods would provide licensees with additional margin but their use is not expected to provide any phenomenological or system response insight that would not also be obtained from the continued use of Appendix K tools and methods. NRC action to provide licensees with incentives to use improved and modern techniques is encouraged by the nuclear industry, but this encouragement stops short of a mandatory requirement to implement newer methods in lieu of well-accepted traditional methods. Appendix K methods, while not the most current, are well understood and acknowledged as a conservative measure of a plant's response to a LOCA event.

Scope of Allow Changes

The process proposed in section 50.xx would be applied to all proposed plant changes following incorporation of the alternative break size into the plant design basis. Because a pre-defined list of applicable changes will not exist, the challenge to identify a defined scope of allowed changes is difficult. Instead, we propose that the change process itself provides the necessary constraints and safeguards. This process, making use of Reg. Guide 1.174 principles requires that each change maintain consistency with the defense-in-depth philosophy, maintains safety margins, constrains the risk impact of changes and ensures that the changes do not invalidate the original basis for the alternative break size definition. The performance of a risk assessment for all plant changes covering all initiating events and plant modes provides a more comprehensive and defensible measure of change impact than could be provided by a pre-defined list of allowed/disallowed changes.

Beyond Design Basis Mitigation Capability

The risk assessment process outlined in 50.xx requires that the risk impact of proposed changes be assessed for the full range of initiating events. The application of this process, with its assurance that the risk impact of changes is small and that defense-in-depth is maintained, will provide assurance of

continued mitigation capability for beyond design basis events. If a change is proposed that significantly impact the mitigation capability of beyond-design-basis events, this would be reflected in the both the delta CDF and delta LERF assessment. The defense-in-depth requirement will lead to an assessment of each change to assure that there is a reasonable balance between prevention and mitigation and assurance that system redundancy, independence and diversity are maintained. This process would serve to restrict changes that significantly impact beyond-design-basis mitigation capability.

Table 2

Redefinition	Risk Assessment	<ul style="list-style-type: none"> • Risk-informed process that provides reasonable confidence that the combined contribution to risk from break sizes greater than the alternative break size are small. • Based on an integrated, systematic process for addressing initiating events (internal and external), SSCs, and plant operating modes, including those not modeled in the plant-specific PRA. • All aspects of the integrated, systematic process used to assess the risk contribution of break sizes greater than the alternative break size must reasonably reflect the current plant configuration and operating practices, and applicable plant and industry operating experience.
	Defense-in-Depth	Evaluation not required – no change to plant design or operation
	Safety Margin	Evaluation not required – no change to plant design or operation
	Beyond Design Basis Mitigation Capability	Evaluation not required – no change to plant design or operation
	NRC Submittal	License amendment submittal to NRC describing risk assessment and process to address future plant changes
Change Process	Risk Assessment	<ul style="list-style-type: none"> • Determine the risk impact of the change using an integrated, systematic process for addressing initiating events (internal and external), SSCs, and plant operating modes, including those not modeled in the plant-specific PRA. • The functions to be considered include design bases functions and functions credited for mitigation and prevention of severe accidents. • All aspects of the integrated, systematic process used to assess the risk impact of the change must reasonably reflect the current plant configuration and operating practices, and applicable plant and industry operating experience. • The evaluations must provide reasonable confidence that sufficient safety margins are maintained and that any potential increases in core damage frequency (CDF) and large early release frequency (LERF) resulting from use of the alternative break size are small.
	Defense-in-Depth	Per Reg. Guide 1.174 – D-in-D evaluation covering full range of events to demonstrate that system redundancy, independence and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers)
	Safety Margin	The determination of sufficient safety margins for any proposed changes following a redefinition of the design basis LBLOCA would involve a determination that the safety analysis acceptance criteria are met for the revised licensing basis and would be performed as part of the “50.59” review associated with the change.
	Beyond Design Basis Mitigation Capability	The risk assessment process, with its assurance that the risk impact of changes is small and that defense-in-depth is maintained, provides assurance of continued mitigation capability for beyond design basis events.
	Monitoring Program	The licensee shall monitor the combined impact of plant changes, operating practices, and applicable plant and industry operating experience to assure that the basis for identification of an alternative break size remains valid.
	Scope of Allowed Changes	Requirements established for evaluating plant changes (risk assessment, defense-in-depth, safety margins and severe accident mitigation capability) serve to establish the appropriate scope of allowed changes.