

POLICY ISSUE NOTATION VOTE

March 3, 2004

SECY-04-0037

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: ISSUES RELATED TO PROPOSED RULEMAKING TO RISK-INFORM
REQUIREMENTS RELATED TO LARGE BREAK LOSS-OF-COOLANT
ACCIDENT (LOCA) BREAK SIZE AND PLANS FOR RULEMAKING ON LOCA
WITH COINCIDENT LOSS-OF-OFFSITE POWER

PURPOSE:

To request Commission direction and additional guidance on policy issues that would facilitate resolution of identified technical issues associated with a proposed rule that would allow licensees to make changes to their facilities and current licensing bases based upon an alternate maximum design basis LOCA break size, as discussed in a staff requirements memorandum (SRM) of March 31, 2003.

To request Commission approval of the staff's revised approach to proceed with a proposed rule to risk-inform the current requirements for consideration of a large break LOCA (LBLOCA) coincident with a loss of offsite power (LOOP).

BACKGROUND:

In SECY-02-0057, "Update to SECY-01-0133, 'Fourth Status Report on Study of Risk-Informed Changes to the Technical Requirements of 10 CFR Part 50 (Option 3) and Recommendation on Risk-Informed Changes to 10 CFR 50.46 (ECCS Acceptance Criteria)'," the staff

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recommended the development of certain risk-informed approaches to technical requirements in 10 CFR 50.46 (and related provisions) related to ECCS reliability, LOCA acceptance criteria, and ECCS evaluation models.

In its March 31, 2003, SRM on this paper, the Commission directed the staff to undertake several rulemakings. The SRM directed the staff to complete the technical basis supporting the large break (LB) LOCA redefinition, supported by a 10-year estimation of LOCA frequencies, and to provide proposed rule changes to the Commission. Through the staff's evaluation of the SRM direction, possible rulemaking approaches, available technical information and stakeholder input, a number of policy and technical issues have been identified that need to be resolved to ensure that the new rulemaking for LBLOCA redefinition does not result in any unintended consequences. The complexity of resolution of these issues depends in large part upon the extent of the changes in a plant's design and operating requirements resulting from LBLOCA redefinition. Therefore, this paper seeks Commission policy direction on the scope of changes so that the staff can proceed with development of a proposed rule.

Following issuance of the SRM, the staff conducted two public meetings to gather stakeholder input on various aspects of the proposed rulemakings and related technical requirements. In addition, NRC participated in an international conference on the topic of potential LBLOCA redefinition. Industry representatives expressed concern about certain aspects of the SRM provisions, such as the scope of probabilistic risk assessments (PRA), and how the scope of acceptable facility changes enabled by the rulemaking would be defined. Industry representatives described a broad range of desired or potential plant changes which could be realized from the redefinition of LOCA requirements now included in a facility's current licensing basis, such as power uprates, increases in power peaking factors, removal of accumulators and reduced flow rates for containment sprays.

The industry representatives indicated that depending upon what a proposed rule would allow as plant changes, licensees may not be prepared to invest significant resources in such areas as PRA improvements unless there was sufficient operational and design flexibility resulting from implementation. The Nuclear Energy Institute suggested an approach to the rulemaking that would use risk contribution from excluded LOCAs as the basis for the redefinition, with the intended scope of application being throughout Part 50. This proposal did not identify specific provisions on mitigation of LOCAs beyond the new maximum break size and other aspects that the staff would view as needed for a defensible risk-informed rulemaking.

In this paper and its attachments, the staff has included discussion of items that are termed "policy direction or guidance issues" and also items called "technical issues." The staff is requesting Commission direction at this time on the former category to enable the staff to move forward with resolution of the technical issues; topics in the latter category require further development by the staff.

The SRM also directed the staff to prepare a proposed rule that would relax the current requirements for consideration of LBLOCA with coincident LOOP. This paper also provides information about the staff proposal for this rulemaking.

As this paper was being finalized, two staff members indicated that they did not concur with some of the text in the final draft. The memorandum and note which discuss the non-concurrence and a memorandum which acknowledges the views are attached (Attachment 1).

DISCUSSION:

A “break size redefinition” in its simplest form would result in the elimination of certain requirements (i.e., requirements placed on important equipment within the design bases of the plant under specified conditions). Its purpose would be to allow plant changes where the particular changes would be permitted by the removal of certain break sizes from a plant’s licensing basis. However, fundamental to the concept of redefinition is establishing the scope and means of application of the redefinition with respect to what changes can actually be implemented at a plant. A more complex or broader rule could result in numerous changes including removal of safety-related equipment. Implementation of a redefinition rule would require license amendment requests to document the review and acceptance, or rejection, of changes to a plant’s current licensing basis. Also, implementation of a redefinition of LBLOCA is likely to result in changes to the plant with respect to the plant’s response to large break LOCA that would also affect response to other initiating events, and thus to the overall risk of the plant.

POLICY DIRECTION REQUESTED

Broad vs. narrow scope rule

The staff seeks a decision from the Commission on how narrowly or broadly (with respect to the scope of allowed changes) the redefinition of the maximum LOCA break size should be applied. In the SRM, the Commission stated that it would not support changes to “functional requirements” unless they are fully risk-informed and protective of public health and safety. For example, the Commission stated it would not support actual changes to ECCS coolant flow rates. The SRM further states that operational changes should be reversible. The above statements would support development of a redefinition rule that would be applied narrowly, with few, if any, actual changes made to the installed structures, systems, and components (SSCs) at a plant. Other statements in the SRM (such as the references to “throughout Part 50” and to pertinent changes in the design basis that would be expected to “occur naturally” from redefinition), could be read as supporting a broader risk-informed application of LBLOCA redefinition which could lead to significant changes, including removal of SSCs currently credited for mitigating the double-ended guillotine (DEG) LBLOCAS.

The SRM also stated that the Commission would support changes to “functional requirements” that are fully risk-informed and protective of public health and safety. The staff understands “fully risk-informed functional change” to be changes such as, but not limited to, those which (1) conform to a RG 1.174-type process where the calculated increases in risk resulting from the plant changes remain within specified bounds (to be determined), and (2) retain adequate defense-in-depth and safety margins to account for uncertainties.

As discussed earlier, the industry has proposed a rule that would broadly apply the redefinition anywhere that LOCA requirements exist throughout Part 50. Some industry representatives have expressed interest in changes that are very significant. For example, a broad scope rule could enable a licensee to pursue a power uprate for a plant that is currently DEG LBLOCA limited. The effect of a significant power uprate would essentially result in a reduction of ECCS

capability, since it would increase the performance demands on the ECCS. Another candidate mentioned by industry is changing power peaking factors. A significant increase in power peaking factors could result in localized or possible propagated core damage if inadequately cooled.

A broader rule that would enable more significant changes, which could naturally flow from removal of the DEG LBLOCA from the licensing basis such as removal of SSCs from current regulatory requirements, would be of greater interest to the industry. If the Commission chooses a broad scope rule, it will be more complex for licensees and the staff to ensure that potential plant modifications do not result in unacceptable changes in the plant's ability to prevent and mitigate beyond design basis events.

A narrow scope rule would be one in which currently installed SSCs remain in place and continue to perform their existing safety functions. Such a rule would permit changes in operating conditions, including timing and sequencing of recovery actions. This type of rule would be simpler to develop and implement. Another option that would be relatively simple to implement is a rule that specifically lists hardware changes that the NRC finds acceptable, based upon acceptance criteria such as limited increase in risk. Plant-specific considerations would likely make this list relatively small in terms of what changes are seen as acceptable generically. Some changes that might be acceptable under a narrow-scope or focused revision to 10 CFR 50.46 may already be available via other risk-informed processes such as changes using RG 1.174, risk-informed Technical Specification changes, or, if approved by the Commission, the final rule for 10 CFR 50.69 (special treatment).

The staff proposes to provide a plan, with detailed schedules and resource estimates, within six months of receiving policy direction from the Commission, as the means to move forward with this rulemaking.

Safety Implications of broad or narrow scope rule

A redefinition of the LBLOCA can potentially have significant impact on plant risk for both broad and narrow scope rule alternatives. The physical design of a nuclear power plant is driven in many ways by the design basis events analyzed in Chapter 15 of a plant's final safety analysis report. At most plants, the design bases LOCA analysis is a primary influence on the design.

For design basis LOCA analysis, the number, size, capacity, response time, and other features of installed SSCs are those necessary to cover the full LOCA spectrum, under postulated conditions (e.g., worst time in core life, worst single failure, coincident loss of offsite power (LOOP), most limiting break location). The SSCs necessary to meet the ECCS criteria are then considered safety-related and are subject to a full range of regulatory requirements (e.g., functional performance, "special treatment," inclusion in technical specifications). If breaks above a certain size are "outside the design basis," then those SSCs or features that previously mitigated these, but not other, design basis events would no longer be viewed as "required" and no longer be subject to the same set of requirements (i.e., §50.44 removal of hydrogen recombiners). All other risk-informed applications have a pre-defined limit to the scope of changes authorized, whereas a broad scope rule approach could either authorize or result in a wide range of modifications.

A significant aspect of developing and implementing a revised set of requirements for LOCA will be the consideration of the implications of various ways that redefinition might be implemented, while still maintaining low plant risk and adequate protection. For example, the robust containment structures are an example of the impact of LBLOCA during design. Ensuring acceptable containment performance without the current LBLOCA requirements will require careful evaluation.

Nuclear plants are not specifically designed to mitigate beyond design basis accidents; however, the extensive margin and redundant systems arising from design basis evaluations have resulted in plant designs that have considerable robustness and capability to mitigate potential severe accident scenarios. Therefore the low plant risk currently seen in U.S. designs derives in part from the abundant system capability due to the original design basis accident requirements. Maintaining appropriate beyond design basis capability in order to assure an acceptable level of risk is a key technical challenge for the §50.46 rulemaking. Reductions in the capabilities of these features will reduce the existing margins and redundant system capacities on which many of the current risk-informed applications rely to offset risk increases authorized by the specific applications.

GUIDANCE REQUESTED

As discussed in more detail in Attachment 2, the staff asks for Commission guidance in the following areas:

- Mitigation of large break LOCAs [Does the Commission agree that some degree of mitigation capability must be retained for break sizes between a new maximum break size and the DEG break] and to the method of providing mitigation [Does the Commission agree that primary mitigative capability for beyond design basis LOCA should be retained through system functional capability, rather than reliance on SAMGs which are voluntary programs, often directed to post core damage actions].
- Reversibility [Does reversibility extend beyond increases in LOCA frequency and what is the relationship between the backfit rule and reversibility].
- Use of Best Estimate Evaluation Models [Should licensees have to reanalyze small breaks in the design basis with best estimate models].
- Future Plants [Should rulemaking for future plants be a separate effort].

TECHNICAL ISSUES

Attachment 3 discusses the issues the staff has identified as requiring more technical and regulatory development. These issues are: the alternate maximum break size selection metric, appropriate limitations on what can be modified in a plant and how this would be codified, defense-in-depth considerations, control of the total (cumulative) risk change, and perhaps most importantly, “mitigation” capability (realistic rather than design-basis) to be retained for break sizes between the new maximum design basis LOCA size and the DEG break. For each of the areas in which technical issues are raised, the staff identifies what activity is needed to come to resolution, and how this information depends upon the policy decision requested

above. These discussions identify differences in the required resolution of the issue depending on whether the narrow scope or broader scope option is selected.

The PRA scope and quality will be important issues underlying the rulemaking. The information about the PRAs to be docketed and the licensee programs to ensure that PRAs are appropriately maintained are also important implementation issues. In the action plan being developed in response to the December 18, 2003, SRM on PRA quality and scope for decisionmaking, the staff will consider the needs of LOCA redefinition (whether narrow or broad), with respect to requirements, standards, and guidance. Therefore, this subject is not discussed as a technical issue in the attachment.

LOCA/LOOP RULEMAKING

The Commission also directed the staff, as a separate activity, to prepare a proposed rule to relax the assumed coincident LOOP required for LOCA analysis. This rulemaking involves many of the same technical issues as the redefinition rule, and a few others (e.g., conditional LOOP probability). In the near future, the staff expects to receive a topical report and pilot plant request for exemption on a set of changes involving this subject. The staff believes it would be valuable to complete the review of the topical report before undertaking a rulemaking involving LOOP. Certain technical resources are in short supply, and the staff could not support all of these activities in parallel. In view of the investment made by the BWROG in the topical report, and the lessons-learned that the staff would expect to apply to any subsequent rulemaking, the staff recommends that the Commission approve the staff's plan to finish the review of the topical report, and pilot exemption, and then develop a schedule for this rulemaking. The staff will inform the Commission of its review schedule for the exemption and its subsequent rulemaking plans within 3 months of receipt of the pilot exemption application.

RESOURCES:

There are resources in the budget for the two discussed rulemakings in NRR's budget for FY2004 and FY2005 of 2.2 FTE. The budgeted resources for technical support activities for RES are 2.5 FTE and \$780k for FY2004 and 0.4 FTE and \$150k for FY2005. The total estimated resources to support the technical work necessary to finalize the technical basis for the rulemaking would vary based upon the Commission's direction related to scope of the redefinition rule. Additional resources (FTE and funding) will be needed for technical basis development that is presently unbudgeted. Resource information will be provided in the redefinition plan noted above and with the staff's plan for reviews related to LOOP. Depending upon the Commission's direction, the complexity and number of technical issues involved in this effort may also require significant redirection of resources from other risk-informed activities.

COORDINATION:

The Office of the General Counsel has no legal objection to this paper.

The Office of the Chief Financial Officer has reviewed this Commission paper for resource implications and notes the potential for unbudgeted requirements. Offices will consider unbudgeted resources through the PBPM process. The staff will be discussing its plans and technical bases with the Advisory Committee on Reactor Safeguards in April 2004.

RECOMMENDATION:

The staff requests that the Commission:

1. Provide policy direction with respect to scope of the redefinition rule.
2. Provide guidance in the areas noted in Attachment 2.

The staff recommends that the Commission:

1. Approve the proposal to prepare a plan for the redefinition rule, including resource and schedule information, six months after the staff receives the above Commission direction.
2. Approve the staff's proposal to first review the BWROG pilot exemption request and subsequently proceed with rulemaking on LOCA/LOOP.

/RA/

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- Attachments:
1. Nonconcurrency Acknowledgment Memorandum
 2. Areas for Guidance
 3. Technical Issues and Activities for 50.46 Rulemaking (Redefinition)

The Commissioners

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Package: ML040550014
SECY w/attach 2&3: ML040490133
Attach 1: ML040550329, ML040540938,
and ML040540939

WITS NO.:WITS 200300048

*Per Telecom

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OFFICE	OGC	ADIP	RES:D	NRR:D	OEDO
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AREAS FOR GUIDANCE

In the sections below, the staff presents four areas in which Commission guidance is sought.

GUIDANCE AREA 1: Retention of Mitigation Capability

The staff seeks Commission guidance on whether appropriate beyond design basis accident mitigation capability must be retained in regulatory requirements for loss-of-coolant accidents (LOCA) larger than the new maximum design basis LOCA up to the double-ended guillotine (DEG) break size, so that a LOCA greater than the new maximum design basis is not expected to result in reactor vessel failure and early containment failure.

With removal of certain break sizes from the licensing basis, whereby these events are no longer required to be mitigated in the way they once were, the question arises about what degree of mitigation should be retained for LOCAs between the new maximum design basis LOCA break size and the largest DEG break size and how this should be required. As discussed in Attachment 3, success criteria for mitigating LOCAs, which would be larger than the new maximum break size could include criteria such as limits on fuel, reactor coolant pressure boundary or containment performance. If no mitigation capability were retained, then plant changes under a broad scope rule (e.g., large power uprates, modified core peaking profiles, structures, systems, and components (SSC) modifications) might create situations where a LOCA beyond the new maximum LOCA break size up to the DEG break could lead to core melt and potential vessel failure, resulting in a large early release and prompt early fatalities, even if all emergency core cooling system (ECCS) equipment in the plant worked as designed. While the staff believes that mitigative capability should be maintained, the staff also believes the capability should be less than presently required for design basis accidents with respect to requirements for redundancy, SSC qualification, and analysis methods.

In addition, the Commission suggested that it might be useful to place guidance on acceptability of mitigation capability for breaks between the new maximum design basis LOCA and the DEG break into the severe accident management guidelines (SAMGs) at plants. There will be large uncertainties in the estimated frequency of the breaks removed from the design basis. It should be noted that the SAMGs are entirely voluntary on a licensee's part, and may be removed by a licensee without NRC approval. The SAMGs focus largely (but not exclusively) on post-core damage actions including operator recovery actions. The staff believes it may be more appropriate that the mitigative guidelines result in plant system capability such that vessel failure and large early release are not expected for LOCAs greater than the new maximum design basis LOCA break size (as further discussed in Technical Issue Area 4 in Attachment 3).

The staff therefore asks, does the Commission agree that primary mitigative capability for beyond design basis LOCA should be retained through regulatory requirements, rather than reliance on SAMGs that are voluntary programs, often directed to post core damage actions?

GUIDANCE AREA 2: Reversibility

The staff seeks Commission guidance on two aspects related to “reversibility”: (1) whether the “reversibility” concept applies if something other than LOCA frequency changes in a manner that the core damage frequency (CDF) and large early release frequency (LERF) differential or cumulative limits were exceeded, and (2) whether backfit analyses should be performed if reversibility is exercised.

The staff requirements memorandum (SRM) states that operational changes should be reversible if the (10 year) re-estimation of LOCA frequencies results in unacceptable LOCA frequency increases. Other changes could lead to increases in risk from large break (LB) LOCAs, for example, equipment reliability might decrease, new transient initiators may occur or probabilistic risk assessment (PRA) models and assumptions could change.

The staff notes that for reversibility resulting from “unacceptable increases” in LOCA frequency, under a redefinition rule, it may be necessary to restore certain break sizes to the design basis, with resultant needs for analysis and requirements at that point to show compliance with §50.46. Such restorations to the design basis, with these consequent actions necessary for compliance with §50.46, would not constitute “backfitting” as defined in the Backfit Rule, 10 CFR 50.109.

Notwithstanding the staff’s determination that such restoration would not constitute backfitting, the staff seeks clarification whether the Commission believes as a matter of policy that the provisions of the Backfit Rule should be complied with before requiring such restorations and reanalyses. A policy decision in favor of requiring that backfit analyses be performed will likely necessitate changes to the Backfit Rule, as well as a specific provision in the redefinition rule. Implementation issues such as whether to require a plant shutdown would also need to be addressed.

1. The staff asks whether the plant, under such circumstances, would have to exercise “reversibility” and bring the total CDF, LERF, or delta risk values back within the original rule acceptance criteria (either by undoing a change or through other actions)? Monitoring and reversibility are necessary components for a broad scope rule, but could be more limited for a narrower-scope rule (see also discussion of cumulative effects in Attachment 3).
2. The staff recommends that backfit analyses should *not* be required where restorations to the design basis and other actions are necessary because the licensee is unable to maintain compliance with the relevant LBLOCA criteria in the proposed rule as the result of changes in plant design and operating characteristics (or new information such as revised frequency estimates).

GUIDANCE AREA 3: Use of Best-Estimate Evaluation Models

The staff seeks Commission policy guidance on the issue of use of best-estimate codes. In particular, we seek this clarification for breaks remaining within the design basis.

The SRM stated, “licensees who seek the benefit of the changes that redefine the design basis large break LOCA requirements should be required to use best-estimate codes. The staff should include such a modification in the proposed 10 CFR 50.46 rulemaking.” These statements appear under a heading of ECCS evaluation model, with other comments about Appendix K. The approach laid out in §50.46(a)(1)(i) is sometimes referred to as “best-estimate,” although the staff believes “realistic” is a better representation. Thus, the staff has interpreted this statement to mean that the Commission intends use of a model consistent with §50.46(a)(1)(i). The staff further notes the SRM also states that §50.46 should be modified to require that future applicants for design certification or for future construction should use best-estimate codes for LOCA analyses.

Stakeholders have expressed concern as to whether the SRM direction would require them to use such “best-estimate” ECCS models for all break sizes remaining within the design basis, as a condition for being able to use the risk-informed alternative break size. Approved §50.46 (a)(1)(i) evaluation models do not currently exist for the full spectrum of break sizes (in particular small breaks) or for all vendors. The NRC staff has not reviewed or approved any §50.46(a)(1)(i) realistic small break LOCA evaluation models for the current fleet of BWR or PWR nuclear power plants. Development and review of such models would require both industry resources and NRC resources, which currently are not budgeted. The staff recognizes that 10 CFR 50, Appendix K evaluation models are more conservative than §50.46 (a)(1)(i) models, and a licensee wishing to realize the full benefits of the new rule could voluntarily develop and apply these §50.46 (a)(1)(i) models.

The staff therefore asks, does the Commission intend that a licensee use “realistic” models (conforming with §50.46(a)(1)(i)) for the entire spectrum of breaks, regardless of whether affected by changes resulting from the redefinition; that the models be used only for the larger breaks, for purposes of showing compliance with §50.46 after implementation of changes; or some other purpose?

GUIDANCE AREA 4: Redefinition Applicability to Future Plants

The staff seeks policy guidance concerning consideration of LOCA redefinition for future plants as part of efforts separate from this rulemaking.

With respect to future plants, the SRM included two statements, one pertaining to use of best-estimate models (see above), and the other stating “the staff should maintain similar margins in future plant design certifications, even if we ultimately adopt a revised LBLOCA definition.”

The staff believes that LOCA redefinition for future plants should be pursued on a separate path from rulemaking for existing designs. The staff envisions that a redefinition rule would cover two areas, first being how a new maximum design basis LOCA break size is determined, and second being what can be done with respect to changes in design and/or operation. For a plant that has not yet been designed or constructed, it may be preferable to apply criteria to the design as a whole. The question of LOCA redefinition also ties into broader considerations about what design basis events should be for future reactors.

The staff therefore asks, does the Commission intend that design basis event for future plants be pursued on a separate path?

TECHNICAL ISSUES AND ACTIVITIES FOR 50.46 RULEMAKING (REDEFINITION)

Technical Issues

The staff has developed a basic redefinition rule structure as outlined below (which corresponds more closely with a broad scope approach rule), which led to identification in many instances of the technical issues discussed herein. The technical issues below do not correspond directly to the issues listed because certain aspects will be covered by the rulemaking development, rather than in the technical basis development which is the subject of this attachment. The staff envisions that the rule would:

- A. Define how the new design basis maximum break size is determined.
- B. Define what it means under the rule to remove an event (large breaks, breaks without coincident LOOP) from the design or licensing basis, i.e., what such a removal means legally and technically with respect to current rule requirements, plant design, and plant operational limits.
- C. Include criteria for assessing acceptability of facility changes to be made by licensees.
- D. Include information to be supplied by a licensee about the analysis, methods, or other material to support the application.
- E. Define the implementation process.
- F. Define the conditions under which the allowed changes might need to be revised over the lifetime of the facility.

The staff anticipates that NRC review and approval will be needed for a licensee to modify its plant using an alternative maximum LOCA break size. The information to be reviewed would vary based upon the specific rule option chosen. With a broader scope rule, significantly more information would be required to be reviewed by the staff. The information to be reviewed would include information about the scope of licensee PRAs, and the quality processes applied. In addition, license amendments would also be necessary for some of the possible changes because technical specifications would have to be revised; however, the extent of the accompanying staff review would depend upon what was already established through the rulemaking.

TECHNICAL ISSUE AREA 1: Break Size Determination

The staff is scheduled to provide a Commission paper on March 31, 2004, presenting the re-estimation of LOCA frequencies. The paper will summarize the expert elicitation effort to develop LOCA break frequency distributions, including the elicitation scope and objectives. The analysis methodology and results will also be presented in context with previous results. The implications, applicability, and limitations of these results for rulemaking will also be discussed.

The March 31, 2003, SRM suggested that the selection of the alternate maximum break size could be developed from risk metrics such as some percentage of the total risk rather than the total risk from LOCAs. Identification of the most appropriate LBLOCA selection metric and numerical criteria will be developed as part of the technical basis associated with this issue. At this time the staff believes that the most appropriate metric to determine the design basis LOCA maximum break size is the direct LOCA initiating event frequency estimates (LFE) (being developed by the staff as noted above). The staff has to resolve several technical issues regarding break size determination in order to support an adequate rulemaking. The recommended values of LOCA frequency that would determine the maximum LOCA break size could vary depending on the rigor of other criteria in the rule and the scope of the rule. A LFE, which is based on the expected frequency of pipe breaks, is thought to be a more direct metric, unlike calculations of plant CDF or LERF that could vary significantly as new PRA methods are incorporated, plant modifications (other than those under this rule) are made, and other changes occur that affect plant risk. The staff believes it undesirable to have a process that either results in plant-specific break sizes or that can change over time due to many factors not directly related to break frequency. Regardless of the break size selection metric recommended, the staff will ensure that the process is risk informed and consistent with the principles of Regulatory Guide (RG) 1.174, as the Commission directed.

The staff is evaluating the technical issue of how far into the future the LOCA frequencies should be projected for a plant, given the projected 60 year life of many nuclear power plants. The staff is considering recommending projection beyond 10 years out be adopted. This would help reduce the potential for having to reverse changes and would reflect the large uncertainties associated with new piping degradation mechanisms.

The staff believes the selection of the new alternate maximum break size is of moderate complexity for either a narrow or broad scope rule approach. The role it plays in the overall rule and decisionmaking, and the means of dealing with the uncertainties is expected to be greater for a broad rule where more extensive changes to the plant might result.

Technical Issue Area 1 Resolution (Break Size Selection)

1. Determine the appropriate LFE value to use for identification of the corresponding redefined LOCA break size and identify what confidence level should be utilized in selecting the new break size. Utilizing the break size-frequency curves (developed from the RES expert elicitation process), identify the redefined LBLOCA size applicable to various categories of plants if a

generic definition is possible. If not, specify the plant specific implementation process necessary to determine the appropriate plant specific break size. (NRR lead)

Complexity: Moderate complexity for either narrow or broad scope approach.

2. Identify the level of mitigation appropriate for the selected LFE with respect to breaks above the redefined LBLOCA size. Identify the appropriate metric(s) to be used. This information will be applied as input for resolution of the mitigative measures technical issue (see activity 7 below). (NRR lead)

Complexity: Moderate complexity for narrow scope rule due to limited extent of changes. High complexity for broad scope rule due to potential for far reaching impacts on the plant's beyond design basis capability.

TECHNICAL ISSUE AREA 2: Plant Change Criteria

The Commission indicated in its March 2003 SRM that there should be regulatory oversight over the changes to the plant that would be allowed as a result of changing the maximum LOCA break size. It would be consistent with the philosophy of RG 1.174 to include plant change criteria associated with core damage frequency (CDF) and large early release frequency (LERF) in such a decision-making process. The staff has identified some technical issues¹ concerning selection of appropriate plant change criteria, control of plant changes allowed under the rule so that unintended changes and outcomes are not authorized, and selection of appropriate criteria to control plant changes under this rule where plant-specific total CDF estimates exceed certain limits. The staff believes that this area will be of moderate complexity for a narrow scope rule, and of high complexity for a broad scope rule.

The staff will address the technical issue of how to develop criteria, including the appropriate metrics, to determine if the proposed plant changes under this rule have an acceptable effect on estimated risk. The staff expects that in implementing the rule, once specific plant changes are postulated, the licensee would need to compare the effect of its proposed changes to the staff's criteria as a first step to determine if the plant change would be acceptable. To do this, a licensee would modify its PRA (or other risk assessment tools) to estimate the expected CDF and LERF increase or decrease if the changes were made. The licensee would then compare the calculated risk increase (or decrease) to the staff's criteria (likely to be delta CDF and delta LERF). The staff is considering establishing lower values for acceptable delta CDF and delta LERF estimates (as the values indicating the boundary between an acceptable and unacceptable change) for plants that do not have full-scope PRAs, and higher values of delta CDF and LERF for plants that have a full scope PRA or nearly a full scope PRA (e.g., a site in Florida might not need a seismic PRA due to the extremely low seismic hazard in the area). Lower values of acceptable delta CDF and LERF would reflect the higher levels of uncertainty due to the incompleteness of risk estimates developed for plants that do not have a full-scope PRA. Plants using risk assessment methods other than PRAs (e.g., the Fire-Induced

¹ The staff's preliminary conclusion is that the numerical criteria listed in RG 1.174 for defining acceptable changes to a plant's licensing basis are not stringent enough to use for modifying the fundamental building blocks and protections provided in the current regulations. Regulatory Guide 1.174 criteria for licensing basis changes are premised on a plant continuing to meet all the underlying regulatory requirements set out in the NRC's regulations even as changes made may result in a small increase in CDF or LERF.

Vulnerability Evaluation (FIVE) fire methodology) would need to justify that the methods used produce realistically conservative numerical results and appropriate safety insights compared to full-scope PRAs and would need to use sufficiently conservative risk assessments in their delta risk calculation, or would need to justify that the method is capable of accurately determining the expected change in CDF or LERF.

The staff will address the technical issue of how to control changes under the rule. If a narrow scope rule were promulgated that specified the only allowable changes, the effort to prevent unintended outcomes would be significantly lessened. The downside of this type of rule is that the changes allowed would probably be limited, given the current technical basis for changes that is available to the staff. If a decision was made to promulgate a broad rule, it would be significantly more challenging to develop risk informed requirements that assure plant changes do not result in unintended outcomes. The staff will develop criteria that must be able to withstand technical and legal scrutiny as to their specificity to limit unacceptable changes. The staff will seek to develop criteria that provide this assurance with reasonable NRC and industry resource expenditures.

The staff will address the technical issue of how total plant risk (i.e., CDF and LERF) should be factored into the risk-informed decision making process under this rule. The staff believes that plant modifications made under this rule should be limited if the total CDF at a plant exceeds a threshold (similar to the process for licensing basis modifications using RG 1.174). The staff will determine this threshold and will address how plants without a full scope PRA should estimate their total CDF. It is the staff's intention to provide additional benefits to licensees that have invested the resources to develop a full scope PRA.

As discussed in this paper, the staff seeks Commission direction on the issue of functional changes. The March 2003 SRM stated that the Commission does not support changes in functional requirements unless they are fully risk-informed. One option on functional changes is for the Commission to not allow any functional changes, such as changes to flow rates of ECCS pumps or other "natural changes" such as extensive power uprates, changes to core thermal limits, or reduced capability of accumulators. However, it is unclear if there would be any industry interest in such a rule, as its application would be very limited. Such a limitation would provide the most assurance that no significant degradation of the underlying protection of a power plant's design bases was allowed by the rule. A second option is to allow fully risk-informed changes to equipment function. Here, by fully risk-informed, the staff means meeting a process similar to that outlined in RG 1.174 including assurance of defense-in-depth and safety margins (See discussion of defense-in-depth). The staff believes that the technical and safety implications of allowing fully risk-informed plant changes are significant and need to be carefully considered, but that with appropriate resolution of the technical issues, the broad scope rulemaking offers the potential to be a useful, safe, alternative set of requirements.

Technical Issue Area 2 Resolution (Plant Change Criteria)

3. Develop criteria, including the appropriate metrics, to help assure the proposed plant changes have an acceptable effect on estimated risk. Develop guidelines or criteria for plants with less than full scope PRAs. Criteria must be specific enough to limit unacceptable changes. (NRR lead)

Complexity: Medium complexity for a narrow scope rule; high complexity for a broad rule.

4. Develop criteria to factor total CDF into the decision-making process such that plant changes are limited if total CDF exceeds some threshold. Criteria must account for plants that have less than full scope PRAs. (RES lead)

Complexity: Moderate complexity for both narrow scope or broad rule approaches.

TECHNICAL ISSUE AREA 3: Defense-in-Depth

Retention of adequate defense-in-depth is an important technical issue when changing the fundamental bases on which most nuclear power plants were designed and built. Defense-in-depth is a philosophy adopted by the NRC to help address uncertainties and unknowns. The defense-in-depth philosophy has evolved over time to address multiple barriers to radionuclide transport, including the fuel, coolant pressure boundary, and containment, and the introduction of engineered safety features to perform a set of safety functions whose ultimate objective is to protect the integrity of these barriers.

The staff believes it is important to take advantage of the guidance already approved by the Commission in Regulatory Guide 1.174, but it may be necessary to further define and expand the guidance for this application. The RG lists seven criteria for maintaining defense-in-depth (of which six of the criteria are pertinent to risk-informing 10 CFR Part 50): maintaining a reasonable balance among prevention of core damage, prevention of containment failure, and consequence mitigation; avoiding over-reliance on programmatic activities to compensate for plant design weaknesses; retention of redundancy, independence, and diversity commensurate with risk; defenses against common cause failures; independence of barriers; and defenses against human errors. Resolution of the issues in this area would be of moderate complexity for a narrow-scope rule, and of high complexity for a broad-scope rule, because of greater potential to affect defense-in-depth when more substantive changes to a plant occur.

The staff will evaluate the technical issue of whether the defense-in-depth criteria in RG 1.174 need to be expanded given that the rule under consideration would potentially revise fundamental protections provided in the current regulations. The RG 1.174 process assumes the underlying regulations are not changed and are always satisfied. The staff's product of this evaluation will list any additional criteria beyond those criteria already documented in RG 1.174 needed to assure adequate defense-in-depth. If the staff's evaluation determines that additional criteria are needed, the staff will request Commission approval to include the criteria in the rulemaking.

Technical Issue Area 3 Resolution (defense-in-depth)

5. If needed, provide additional criteria beyond those already in RG 1.174 to assure adequate defense-in-depth. (NRR lead)

Complexity: Moderate complexity for narrow scope rule. High complexity for broad scope rule approach.

6. If needed, provide guidelines on how to meet the defense-in-depth criteria already in RG 1.174 for changes resulting from this rulemaking. (NRR lead)

Complexity: Moderate complexity for narrow scope rule. High complexity for broad scope rule approach.

TECHNICAL ISSUE AREA 4: Assessment of Mitigation Capability

Another technical issue to be decided, based upon the extent of application of redefinition, is how to select success criteria for determining mitigation capability for LOCA sizes between the new maximum large break LOCA and the DEG break of the largest pipe in the system. These issues would be of moderate complexity for a narrow-scope rule, and of high complexity for a broad-scope rule because of the potential for changes to impact capability to mitigate beyond design basis events.

The staff will evaluate the technical issue on the need to mitigate breaks beyond the new LBLOCA size. The staff will develop criteria for determining if mitigation capability is adequate for LOCAs between the new maximum design basis LOCA size and the DEG break. In addition, the staff will determine how such mitigation should be incorporated into the regulatory process. Depending on the type and degree of plant modifications sought by industry under this rule, the criteria to assure appropriate mitigation of LOCAs between the new maximum design basis LOCA and the DEG break could vary. For some plants the mitigation criteria might be as simple as using best-estimate (realistic) thermal hydraulic models (acceptable to, but not formally endorsed by the NRC) to demonstrate that no core damage occurs. Other examples of potential mitigation criteria include increasing the peak cladding temperature limit, defining limits on the percentage of fuel melt or fuel pin failure that would be allowed, or defining limits on permissible clad oxidation. The objective of these alternatives is to provide confidence that a LOCA greater than the new maximum design basis is not expected to result in reactor vessel failure and early containment failure.

The staff is working in parallel on consideration of whether it is feasible to develop a revised ECCS success criteria for breaks beyond the new maximum design basis LOCA size, which will maintain a coolable fuel geometry. The staff does not expect to formulate a recommendation for how such criteria should be regulated, if at all, until the technical issues associated with mitigation are more fully developed.

The staff also seeks to assess the consequences of a DEG LOCA if a plant were updated and the mitigating system performance were not kept at the level currently required for a DEG break. The staff is also calculating the contributions to CDF from redefining the maximum design basis LOCA size and making some of the modifications suggested by stakeholders. RES efforts are ongoing and draft reports will be available in the 4th quarter, FY 2004.

Available codes at the state-of-the-art level may need additional benchmarking against the phenomena associated with arresting a core melt. RES is performing thermal hydraulic sensitivity cases to evaluate the changes in CDF. These evaluations should take into account the changes in safety margins and defense-in-depth features based on other RES analyses. RES efforts are ongoing and are considered draft at this time (preliminary due-date of 4th quarter, FY 2004).

It has been postulated that it might be useful to place guidance on acceptability of mitigation capability for breaks between the new maximum design basis LOCA and the DEG break into the severe accident management guidelines (SAMGs) at plants. It has already been noted that

there will be large uncertainties in the estimated frequency of the breaks removed from the design basis. It should be noted that the SAMGs are entirely voluntary on a licensee's part, and may be removed by a licensee without NRC approval. Additionally, the SAMGs focus largely (but not exclusively) on post-core damage actions including operator recovery actions. The staff believes it may be more appropriate that the mitigative guidelines result in plant system capability such that vessel failure and large early release are not expected for LOCAs greater than the new maximum design basis LOCA break size. Were reliance to be placed on use of SAMGs for redefinition, there would likely be a need for some type of regulatory control on severe accident management guidelines and procedures.

Technical Issue Area 4 Resolution (Mitigation for Beyond Design Bases LOCAs)

7. Develop a list of criteria to be met (and the technical basis for the criteria) to demonstrate adequate mitigation capability for LOCAs beyond the new maximum design basis LOCA up to the DEG break. (RES lead)

Complexity: Moderate complexity for narrow scope rule. High complexity for broad scope rule due to the potential for far reaching effects on the plant's beyond design basis capability.

TECHNICAL ISSUE AREA 5: Cumulative Effects

The staff anticipates that licensees will make several, if not numerous, modifications to the plant over an extended period while implementing this rule. Each modification to the design or operating characteristics of a plant can change the risk profile of the plant and the effect of all plant modifications arising from redefining LOCA size should be identified and tracked over the life of the plant. The staff will address the technical issue of how the cumulative effect on risk from all the modifications enabled by redefining the LOCA size should be monitored and controlled. In a narrow scope rule, the potential for cumulative effects to be significant is low. A broad scope rule would necessitate consideration of enhanced management of cumulative effects.

Experience from the review of numerous risk informed submittals has demonstrated that tracking the cumulative effect on risk of plant modifications made to a plant is complex. One aspect is that PRA upgrades (whereby nothing in the plant is changed but the PRA models are improved) can increase or decrease the risk associated with a particular SSC or procedure modification. Often, PRA upgrades are made in parallel with updates to the PRA to reflect the modifications to the design or operating characteristics of the plant. It often is difficult to determine if the net change in CDF or LERF is due to the PRA upgrade or actual modifications made to the plant. The commingling of these changes provides a complexity to the accounting of changes in risk. Similarly, modifications over time to the plant and the PRA upgrades may decrease or increase the estimated change in CDF or LERF associated with previous plant modifications.

Monitoring of the change in risk associated with each PRA and plant change has been considered and discussed with industry but has been recognized by both industry and staff as resource intensive. Today, most risk-informed applications (i.e., allowed outage time extensions, inservice inspection, containment leak rate testing) have application-specific processes to ensure that cumulative changes in risk arising from the authorized modifications

are controlled. Cumulative effects of the many different, and potentially substantial, modifications with broad scope changes to the LBLOCA licensing basis will be difficult to assess. A systematic process will require development of analysis guidelines that yield a well defined cumulative risk estimate for all the individual changes authorized by the rule over the life of the plant.

Technical Issue Area 5 Resolution (Cumulative Effects)

8. Determine the information that needs to be tracked for the individual changes authorized by the rule over the life of the plant. Develop analysis guidelines that yield well defined cumulative risk estimates that can be compared to the applicable risk criteria. Develop guidelines for evaluating the cumulative changes against the defense in-depth and other qualitative guidelines. (NRR lead)

Complexity: Moderate complexity for a narrow scope rule because of the limited number of potential changes. High complexity for a broad scope rule, because of issues related to the changing plant risk baseline and different contributions from PRA methodology changes vs. physical plant modifications.