

Enclosure 1

Rule Overview and Summary of ACRS Recommendations

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Overview

The draft final rule divides the current spectrum of loss of coolant accident (LOCA) break sizes into two regions. The division between the two regions is determined by a “transition” break size (TBS). The first region includes small breaks up to and including the TBS. The second region includes breaks larger than the TBS, up to and including the double-ended guillotine break (DEGB) of the largest reactor coolant system pipe. Pipe breaks in the smaller break size region are considered more likely than pipe breaks in the larger break size region. Consequently, each region is subject to ECCS requirements commensurate with the relative likelihood of breaks in that region. LOCAs in the smaller break size region will continue to be “design basis accidents” and will continue to be analyzed by current methods, assumptions, and criteria. In this region, licensees must perform analyses under current § 50.46 ECCS requirements to determine the limiting size and location for breaks up to and including the TBS.

Pipe breaks larger than the TBS, because of their lower likelihood, can be analyzed by the more realistic and less stringent analysis methods established in the new § 50.46a. Although LOCAs for break sizes larger than the transition break will become “beyond-design-basis accidents,” the NRC will include requirements ensuring that licensees maintain the ability to mitigate¹ all LOCAs up to and including the double-ended guillotine break of the largest reactor coolant system pipe. Although these breaks would be mitigated, the analysis methods and initial and boundary conditions used may be more realistic. Licensees would be allowed to take credit for sufficiently reliable non-safety-related systems without assuming a loss of offsite power and/or other independent failures and must show that the core remains in a coolable geometry. The specific metrics for demonstrating “coolable core geometry” are not necessarily limited to a peak cladding temperature of 2200 degrees F and less than 17% local cladding oxidation, as required for breaks smaller than the TBS. Licensees could propose other criteria for assuring coolable core geometry if an adequate technical basis was provided to support the proposed criteria.

Licensees who perform LOCA analyses using the risk-informed alternative requirements may find that their plant designs are no longer limited by certain parameters from previous large-break analyses. The new analyses could enable licensees to propose a wide range of design or operational changes. However, the risk-informed § 50.46a option would establish risk acceptance criteria for evaluating all design changes that would be similar to the criteria for risk-informed license amendments in Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis.” Licensees could use the revised § 50.46a to optimize safety system design and setpoints in ways that could result in a net reduction in risk to public health and safety. However, the proposed rule would also allow licensees to make changes that result in small increases in risk. To control any risk increases, the proposed rule requires that the total increases in core damage frequency (CDF) and large early release frequency (LERF) are small and that plant baseline risk remains small.

¹ The proposed rule requires that licensees maintain the capability to mitigate these large breaks. However, in response to industry comments, the staff is considering if, and for how long, plants may operate in a configuration for which mitigation cannot be shown to be available for all LOCAs.

Summary of ACRS Issues and Recommendations

The recommendations in the November 16, 2006, ACRS letter on the § 50.46a rule raise the following issues:

Issue 1. What should be the basis for determining the adequacy of defense-in-depth and safety margins in reactor designs?

The ACRS letter recommends that adequate defense-in-depth and safety margins to account for unanticipated issues and other phenomena not addressed by risk analysis be based on engineering judgement and not on calculated risk significance (See ACRS letter, p. 2, ¶'s 3 & 4). The Committee said that it is acceptable to allow mitigation analyses for breaks larger than the TBS to exclude assuming the loss-of-offsite power and a single failure, but the staff's rule provides otherwise inadequate mitigation requirements for breaks larger than the TBS (See ACRS letter, p. 1, Rec. 1 & p. 3, ¶ 1). The ACRS also said that the staff's rule provides restrictions on the unavailability of the non-safety-related equipment needed to mitigate breaks beyond the TBS, but this equipment should be subject to requirements for special treatment and control (See ACRS letter, p. 3, ¶ 4). Further, the ACRS recommended that the staff's rule should increase confidence in the ability to mitigate breaks greater than the TBS by requiring licensees to submit the codes used for the analyses of breaks beyond the TBS to the NRC for review and approval (See ACRS letter, p. 3, ¶ 3).

Previously, the Commission directed the staff to determine defense-in-depth and safety margins for mitigating these breaks based on the frequency (i.e. risk significance) of LOCAs larger than the TBS. The Commission stated "The requirements of § 50.46a should be edited to remove the overly prescriptive regulatory treatment of beyond design basis LOCAs to be consistent with the low frequency of these events." (General Comment 1 on p. 1 of July 29, 2005 SRM on SECY-05-0052; ML052100416). The Commission also said, "The mitigation capabilities for beyond design basis events, and any changes to these capabilities, should be controlled by NRC requirements commensurate with the safety significance of these capabilities..." (See last ¶ on p. 1 of July 1, 2004 SRM on SECY-04-0037; ML041830412).

Staff Position:

The requirements for mitigating pipe breaks larger than the TBS reviewed by the ACRS in the draft final rule were based on the staff's interpretation of defense-in-depth direction provided by the Commission. The staff believes that the ACRS recommendation to establish defense-in-depth based on engineering judgement conflicts with previous Commission direction in that the Commission directed that defense-in-depth be based upon risk significance. The particular changes recommended by the ACRS are more conservative than the approach in the draft rule since they would result in additional requirements to increase assurance of mitigation capability for breaks larger than the TBS. The staff does not agree with the ACRS recommendations that thermal-hydraulic analysis methods used for beyond-TBS breaks should receive prior NRC staff approval and that additional special treatment requirements for equipment credited in beyond TBS analyses be included in the rule. The staff believes that risk significance of beyond TBS breaks is too low to warrant such additional requirements.

Issue 2. In determining the transition break size, should the staff also consider the following two factors: 1) the degree of assurance that breaks larger than the TBS can be mitigated, and 2) the potential benefits of a smaller TBS?

Staff Position:

The selection of the TBS was based primarily on the staff's interpretation of Commission direction that the frequency of pipe breaks should be the basis for the TBS. In addition, the staff believes that consideration of additional subjective factors such as "degree of assurance of defense-in-depth," or "potential benefits" in the determination of the TBS would result in a subjective, plant specific process for selecting each plant's TBS. The staff believes that consistency in application of such a process is unlikely and does not recommend implementation of this ACRS recommendation.

Issue 3. What should be the process and the acceptance criteria for determining the acceptability of changes in risk?

The ACRS letter states, "The interpretation that the Rule limits the total increase in core damage frequency (CDF) resulting from all changes in a plant that adopts the Rule to be "small" (i.e., $<1 \times 10^{-5}/\text{yr}$) represents a significant departure from the current guidance for risk-informed regulation and should be reviewed for its implications." (See ACRS letter, p. 1, Recommendation 3). The ACRS also observed that the change control process would allow changes that increases risk up to $1 \times 10^{-5}/\text{year}$ that would not require prior staff review and approval. The ACRS recommended that licensees should submit changes that are expected to increase risk by more than $1 \times 10^{-6}/\text{year}$ for prior staff review and approval (See ACRS letter, p. 3, ¶ 5).

The draft final rule relied on Commission direction to the staff to include a risk-informed change control process and specifying the scope of changes that should be included in that process. The Commission stated, "A change process for proposed plant changes using the rule should follow existing regulations and guidance, (e.g., 50.59 and 50.90, and RG 1.174) and should ensure that the review mechanisms for such changes provide for adequate NRC oversight." (See 3rd ¶ on p. 2 of July 1, 2004 SRM on SECY-04-0037). The Commission also said, "for licensees that use § 50.46a, the integrated, risk informed change process should be used for *all* [emphasis in the original] changes made under 50.59 or 50.90." (See General Comment 2 on p. 1 of July 29, 2005 SRM on SECY-05-0052.)

In addition to the above general guidance, the July 29, 2005, SRM on SECY-05-0052 included an attachment that provided a number of edits that should be made to the rule language. Several edits affected the change control process. Section (f)(2)(i) included the language, "[f]or changes reviewed and approved by the NRC under § 50.90, the total increases in core damage frequency and large early release frequency are small and the overall risk remains small. For changes that do not require prior NRC approval under 10 CFR 50.59, any increases in the estimated risk are minimal compared to the overall plant risk profile." Sections (f)(1) and (f)(6) included language that required that all changes to a facility, technical specifications or procedures be made by requesting a license amendment under §50.90 unless otherwise permitted under §50.59. The proposed rule included requirements consistent with the SRM direction. Instead of requiring all changes to the facility to be made under §50.59 or §50.90, the draft final rule continued to rely on the existing regulations to specify how changes must be

made but required that all changes to the facility must be risk-informed. As stated by the ACRS, the draft final rule limits the total increase in core damage frequency resulting from all changes at a facility that adopts the rule to a “small” increase. Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis” recommends that the total increase from all related changes not exceed a “small” increase. The departure from RG 1.174 guidance was proposed by the staff as the best alternative that combined the Commission direction that the change process follow existing regulations and guidance, that all changes need be risk informed, and that the “total” increases in CDF and LERF are small and the overall risk remains small.

The ACRS recognized that the draft final rule would allow some changes that increase risk up to 1×10^{-5} /year without prior staff review and approval as long as the total increase did not exceed 1×10^{-5} /year. Regulatory Guide 1.174 provides guidance on the use of probabilistic risk assessment (PRA) findings and risk insights in support of licensee requests for changes to a plant’s licensing basis. It does not address licensee-initiated changes that do not require NRC review and approval and provides limited guidance on use of risk-insights when a licensee does not make a risk-informed submittal. The draft final rule proposed by the staff required a risk-informed evaluation of all potentially risk significant changes before the change is implemented, but continued to rely on existing regulations (e.g., § 50.59 and § 50.55a) to identify what changes should be submitted for prior staff review and approval. The staff did not propose an additional risk-informed criterion because the staff believed that the controls established by the draft rule in combination with existing regulations make it unlikely that licensees could make risk-significant changes without prior staff review and approval.

Staff Position:

The staff concurs with ACRS conclusion that the rule would be strengthened by addressing the issues raised in the ACRS letter. The two issues discussed above relate to the use of risk in the change control process. The Committee’s concern that the rule departs significantly from RG 1.174 guidance can be resolved without conflicting with Commission direction by identifying the population of related changes as is done in other risk-informed applications. The ACRS proposal to apply existing guidelines in RG 1.174 to identify what changes must be submitted for staff review will not conflict with Commission direction if the scope of changes that must be evaluated against this criterion is consistent with existing regulations.

Issue 4. Should promulgation of the rule be delayed until updated cladding oxidation acceptance criteria for higher burnup fuel can be included?

In its letter the ACRS said, “It is likely that with this rule, the NRC will find requests for additional power uprates at pressurized water reactors (PWRs) acceptable. However, the uprates will clearly decrease safety margins, even for breaks below the TBS. The rule currently contains acceptance criteria for fuel cladding performance under LOCA conditions based on the current 10 CFR 50.46. The Office of Nuclear Regulatory Research is now completing an examination of the adequacy of these criteria for high-burnup fuel. The adequacy of the acceptance criteria for cladding performance is important to maintain adequate safety margins. The rule should not be finalized until the fuel cladding acceptance criteria for LOCAs involving breaks at or below the TBS are reviewed and/or revised to assure their adequacy for the higher burnup fuel and more demanding conditions of current reactor operating conditions. Alternatively, the acceptance criteria in the rule could be expressed in terms of general requirements, such as a

high degree of confidence in maintaining a coolable geometry and retaining some ductility in the cladding. Specific cladding and core criteria could be placed in the associated regulatory guide."

If the technical basis report does not indicate an immediate safety concern, this rulemaking would be implemented via the normal process which would provide the Commission with a final rule in 2009.

Staff Position:

The staff agrees with the ACRS view that it is preferable to complete the review and revision of the fuel cladding acceptance criteria for LOCAs involving breaks at or below the TBS before finalizing the § 50.46a rulemaking. Such an approach would assure that the issue of adequate safety margin with regard to cladding oxidation is addressed in a generic, structured rulemaking prior to any potential implementation under § 50.46a. This is a logical sequence because changes proposed by licensees adopting § 50.46a will likely result in more demanding reactor operating conditions that may further stress the fuel, or result in small break LOCAs becoming limiting. In addition, the trend toward higher fuel burnups where oxidation effects are most pronounced is expected to continue. Thus cladding safety margin considerations are likely to be important issues in § 50.46a applications.

Although proceeding with the § 50.46a rulemaking by incorporating general cladding acceptance criteria could also be considered, resolution of safety margin questions would then be on a plant specific basis. Plant specific resolution is likely to complicate consistency in the regulatory process. In addition, incorporating general criteria in the near term would also result in the need for a subsequent rule change to § 50.46a when the cladding rulemaking is completed.

Accordingly, the staff agrees with the ACRS that assuring the adequacy of the cladding oxidation criteria before implementing the § 50.46a rulemaking is a more appropriate approach for assuring that adequate safety margins are maintained and for assuring consistency in rule implementation. The current rulemaking schedule for the revised cladding acceptance criteria could result in a delay of several years in issuing of the revised § 50.46a.

Issue 5. Should the rule include a requirement that licensees demonstrate that the results in NUREG-1829 are applicable to their plants?

The ACRS stated, "Although the Rule defines TBSs for BWRs and PWRs, licensees should not presume that these automatically apply to all plants. As part of the adoption of the rule, licensees should have to demonstrate that the results in draft NUREG-1829 are applicable to their plants. The staff should provide guidance for this demonstration in the associated regulatory guide. As part of this demonstration, licensees should demonstrate that the reactor coolant system piping of diameter corresponding to the TBS or larger meets the deterministic requirements currently used to credit leak-before-break for dynamic analysis of reactor coolant piping." (See ACRS letter, p. 4, ¶ 4 & p. 5, ¶ 1).

The staff notes that NUREG-1829 does not provide explicit guidance as to what plant-specific attributes would be considered "key" to ensuring that the NUREG's findings were applicable to

an individual plant thus, implementing this ACRS recommendation would require the staff to develop explicit implementation guidance.

Staff Position:

The staff agrees that the rule should require licensees to justify that the generic NUREG-1829 results are applicable to their plants. The justification could require that licensees verify that plant construction, operation, inspection, and maintenance practices meet the explicit and implicit assumptions which are the foundation of the NUREG-1829 results. The staff plans to develop regulatory guidance which will provide one acceptable method for licensees to provide this justification. However, counter to the ACRS recommendation, the staff does not believe that licensees should be required to demonstrate that deterministic requirements currently used to credit leak-before-break are met for reactor coolant piping having a diameter corresponding to or larger than the TBS. The leak-before-break (LBB) tolerance of large diameter reactor coolant piping was explicitly considered during the expert elicitation summarized in NUREG-1829. Specifically, the experts recognized that large diameter piping that is fabricated, inspected, maintained, and operated under existing regulations demonstrates increased LBB tolerance. The licensee justification described above will provide assurance that each specific plant retains this tolerance without requiring specific LBB calculations for piping equivalent to or larger than the TBS.

Issue 6. Should promulgation of the rule be delayed until after the ACRS has reviewed the staff's resolution of public comments on draft NUREG-1829?

The ACRS letter noted that the staff is revising draft NUREG-1829 to incorporate, as appropriate, the changes resulting from the resolution of public comments. The Committee recommended that the revision should be completed prior to issuing the revised rule (See ACRS letter, p. 5, ¶ 2).

Staff Position:

The current staff schedules for NUREG-1829 and for the § 50.46a rule are consistent with this ACRS recommendation. The schedule for incorporating changes, as appropriate, resulting from the resolution of public comments, and finalizing NUREG-1829 is August 2007. The staff plans to schedule both subcommittee and main committee ACRS meetings in the fall of 2007 to discuss the resolution of public comments and summarize the contents and findings of NUREG-1829. Additional ACRS meetings may be held in the spring of 2007 to provide the Committee with an overview of NUREG-1829. The current schedule should allow the ACRS ample time to review NUREG-1829 to evaluate this component of the technical basis, and understand how the results have been utilized in developing the revised rule. Under the currently proposed schedule for completing the § 50.46a rulemaking, the ACRS would review the final rule in 2008 or 2009, depending upon whether the rule is repropounded for additional public comments.

Issue 7. Should the final rule be delayed until after the ACRS has reviewed the staff's seismic study and should the rule require licensees to demonstrate that the results developed by the staff bound the likelihood of seismically induced failure in their plants?

The ACRS observed that as part of its effort to establish the TBS, the staff performed a study of the likelihood of seismically induced failures in unflawed piping, flawed piping, and indirect failures of other components and component supports that could lead to piping failure. The study focused on piping systems in PWRs east of the Rocky Mountains. The ACRS recommended that the Committee should complete its review of the staff's study in this area before the final rule is issued. Specifically, because seismic hazards are very plant specific, the ACRS recommended that licensees adopting the rule be required to demonstrate that the results developed by the staff bound the likelihood of seismically induced failure in their plants. For unflawed piping, the results of the individual plant examination of external events (IPEEE) program may provide the needed information. Licensees may have to perform additional calculations to demonstrate a comparable robustness of flawed piping. (See ACRS letter, p. 5, ¶ 3).

Staff Position:

The staff agrees that the final § 50.46a rule should not be issued before the ACRS reviews the staff's seismic study. The need for the plant-specific analyses suggested by the ACRS will be addressed as a part of that review. The staff currently plans to discuss the study with the ACRS in the summer of 2007. This schedule is consistent with the ACRS recommendation.