

POLICY ISSUE NOTATION VOTE

March 29, 2002

SECY-02-0057

FOR: The Commissioners

FROM: William D. Travers
Executive Director for Operations

SUBJECT: 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 RECOMMENDATIONS ON RISK-INFORMED CHANGES TO 10 CFR 50.46 (ECCS ACCEPTANCE CRITERIA)"

PURPOSE:

To provide an update of the information provided to the Commission in SECY-01-0133 on risk-informed changes to 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems (ECCS) for Light-Water Nuclear Power Reactors," as directed by the staff requirements memorandum (SRM) dated February 8, 2002.

SUMMARY:

In SECY-01-0133, the staff developed recommendations for Commission consideration on risk-informed changes to 10 CFR 50.46 which included (a) modification of the existing 10 CFR 50.46 to change the ECCS acceptance criteria and the Appendix K ECCS evaluation model requirements and (b) development of a voluntary risk-informed alternative to 10 CFR 50.46 and General Design Criterion (GDC) 35 that would change the ECCS reliability requirements. The staff continues to recommend changes to ECCS acceptance criteria, Appendix K ECCS evaluation model requirements, and GDC 35. Regarding the Appendix K evaluation model requirements, the staff now specifically recommends adding an option that would permit the use of either the current decay heat requirement based on the 1971 American Nuclear Society (ANS) standard or a model based on the 1994 ANS standard. The staff is continuing with the technical work as described in SECY-01-0133, including evaluating the other potential changes to the Appendix K requirements identified in SECY-01-0133. With one exception, the schedules for this technical work have not changed.

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The staff continues to evaluate whether additional changes to 10 CFR 50.46 may be merited, in particular, redefinition of the spectrum of pipe break sizes relevant to this regulation. Several stakeholder organizations have indicated that changing the spectrum of pipe break sizes relevant to 10 CFR 50.46 is one of their highest priorities with respect to risk-informed regulation. A petition has been submitted by industry that, if granted, would allow the option of using an "alternative to the currently required double-ended rupture of the largest pipe in the reactor coolant system in ECCS evaluation models." As discussed in SECY-01-0133, these additional changes to 10 CFR 50.46 require a more complex technical evaluation and thus more time. The staff is continuing its assessment of whether the technical justification for such changes is feasible. If found feasible, the staff recommends that the change be accomplished in a separate rulemaking.

BACKGROUND:

In SECY-01-0133, the staff developed recommendations for risk-informed changes to 10 CFR 50.46 for consideration by the Commission. These proposed changes would impact the requirements of the four technical areas of 10 CFR 50.46 (including 10 CFR Part 50, Appendix K and GDC 35) as follows:

- ECCS reliability. The ECCS is designed to codes and standards applicable to safety-related systems, and it is designed to be reliable by the application of the single failure criterion and specifications on offsite power availability. More specifically, the system is designed to meet specified functional requirements with an assumed single failure and an assumed loss of offsite power simultaneous with the LOCA.

The staff recommended two voluntary performance-based options that would demonstrate that ECCS safety function can be reliably accomplished without assuming loss of offsite power coincident with a single additional failure. One option involves a plant-specific approach, where licensees would demonstrate ECCS safety function reliability commensurate with LOCA frequency, consistent with NRC-specified risk guidelines. The other option involves a generic approach in which the staff defines by plant group a minimal set of equipment required to meet an established ECCS reliability.

- ECCS acceptance criteria. Calculated parameters such as peak cladding temperature, total cladding oxidation, and maximum hydrogen generation are used as metrics for comparison to the specified criteria.

The staff recommended that the current prescriptive ECCS acceptance criteria be replaced with a performance-based requirement, which would allow use of cladding materials other than Zircaloy or ZIRLO without licensees having to submit an exemption request.

- ECCS evaluation model. Appendix K of 10 CFR Part 50 describes the most commonly used method for evaluating ECCS performance by specifying required and acceptable features of ECCS evaluation models.

The staff recommended updating the 10 CFR Part 50, Appendix K requirements based on more current and realistic information. SECY-01-0133 identified possible changes as implementing the 1994 ANS decay heat standard, replacing the Baker-Just zirconium steam model with an alternative model for steam oxidation and heat generation, deleting the requirement for reflood steam cooling for small reflood rates, and deleting the prohibition on return to nucleate boiling during blowdown.

- ECCS spectrum of break sizes and locations. This spectrum includes breaks in pipes in the reactor coolant pressure boundary up to and including a break equivalent in size to the double-ended rupture of the largest pipe in the reactor coolant system.

The staff indicated additional changes related to the spectrum of pipe break sizes relevant to 10 CFR 50.46 may be merited; however, these changes required further technical evaluation and thus more time, as indicated in SECY-01-0133.

These recommended changes were based on a feasibility study, and additional technical work was required before initiating any efforts to move forward with actual rule changes. This paper provides an update of the continuing staff effort on the technical work to support the changes recommended in SECY-01-0133, as well as the status on the staff approach for any possible rulemakings associated with these changes.

DISCUSSION:

This section describes the status of the staff's technical work in support of the changes recommended in SECY-01-0133 in each of the four technical areas described above. The discussions for each technical area include a statement of the recommendations from SECY-01-0133, the status of the technical work to support the recommendations, including identification of any changes in the recommendations, and the status of the staff approach for any recommended rulemakings. With respect to developing the proposed rules for the recommended changes in SECY-01-0133, the staff expressed in the paper that it was not clear whether it would be more effective and efficient to make the recommended changes in one or multiple rulemakings. The staff now considers that unbundling and pursuing a separate rulemaking for each of the proposed changes would be prudent. Since most of the proposed changes are not directly related to each other, the approach of pursuing a rulemaking for separate proposed changes is expected to promote efficiency and effectiveness by accelerating some changes to 10 CFR 50.46. This approach would allow the staff to proceed with proposed rulemaking as soon as the technical work related to a particular proposed change is completed. It is the staff's intent that any rulemakings associated with each of the proposed changes identified in SECY-01-0133 will be voluntary alternatives to the current rules.

As the technical work to support changes to 10 CFR 50.46, 10 CFR Part 50, Appendix K, and GDC 35 has progressed, the staff has routinely met with stakeholders to communicate, receive feedback on, and enhance public confidence in the technical merit of the staff's work. In addition,

the staff has had several discussions with the ACRS (both the sub- and the full committee). The staff plans to continue to meet with stakeholders and the ACRS. Some areas of particular interest to industry include changing the scope of pipe break sizes relevant to 10 CFR 50.46, revising Appendix K to allow use of a decay heat model based on the 1994 ANS decay heat standard, and relaxing the requirement for considering a loss of offsite power coincident with a large-break LOCA. Industry has submitted petitions for rulemaking related to the use of the 1994 ANS decay heat standard (PRM-50-74) and the spectrum of pipe break sizes used in ECCS evaluation models (PRM-50-75).

Changes to the Current 10 CFR 50.46, 10 CFR Part 50, Appendix K, and GDC 35

ECCS Acceptance Criteria

In SECY-01-0133, the staff recommended replacing the current prescriptive ECCS acceptance criteria in 10 CFR 50.46 with a performance-based requirement. This requirement would: (1) demonstrate adequate post-quench cladding ductility and adequate core-coolant flow area to ensure that the core remains amenable to cooling, and (2) for the duration of the accident, maintain the calculated core temperature at an acceptably low value and remove decay heat. Use of a performance-based requirement rather than the current prescriptive criteria would allow use of cladding materials other than Zircaloy or ZIRLO without licensees having to submit an exemption request.

The staff continues to recommend changing the current prescriptive ECCS acceptance criteria in 10 CFR 50.46 to add a performance-based option. The technical work to support this change, consistent with the technical work described in Attachment 2 of SECY-01-0133, includes:

- Research to explore post-quench ductility of high-burnup Zircaloy cladding.
- Interpretation of test results and formulation of the technical basis for a regulatory guide.

The technical work to support changes to the ECCS acceptance criteria will be completed in July 2002, consistent with the schedule provided in SECY-01-0133.

Related to this potential rule change, the staff is reviewing a petition for rulemaking (PRM-50-71) that proposes a rule change to allow nuclear power plant licensees to use zirconium-based cladding materials other than Zircaloy or ZIRLO. SECY-01-0133 indicated that the objective of this petition would be accomplished as a result of the changes to the ECCS acceptance criteria being considered here.

ECCS Evaluation Model Requirements

In SECY-01-0133, the staff recommended revising the requirements for ECCS evaluation models in 10 CFR Part 50, Appendix K to be based on more current and realistic analyses, and indicated that this update could involve:

- replacing the current 1971 ANS decay heat curve with a model based on the 1994 ANS standard and replacing the current decay heat multiplier of 1.2 with an NRC-prescribed uncertainty treatment.

- deleting the limitation on PWR reflood steam cooling for small reflood rates.
- replacing the Baker-Just zirconium steam model with the Cathcart-Pawel zirconium steam oxidation model for heat generation.
- deleting the prohibition on return to nucleate boiling during blowdown.

In addition, the staff indicated in SECY-01-0133 that it would also consider the recognized non-conservatisms and model limitations to ensure that proper safety focus is incorporated in any new rule.

Based on the results of the continuing technical work:

- The staff recommends adding an option to the decay heat requirements in 10 CFR Part 50, Appendix K that would permit the use of either the current decay heat requirement based on the 1971 ANS standard or a model based on the 1994 ANS standard.
- The staff still plans to address the subject of uncertainty and conservatism so that proper safety focus is maintained in evaluation models that utilize a revised Appendix K. Acceptable features for the uncertainty analysis required for the realistic option of 10 CFR 50.46 are described in Regulatory Guide 1.157. Uncertainty analyses for realistic models are further discussed in SECY-83-472. It should be noted that the technical work to date has revealed several issues that pertain to potential non-conservatisms that could be imbedded in some current evaluation models. For example, downcomer boiling, which is usually not addressed in Appendix K evaluation models, would increase peak cladding temperature. The industry has agreed to provide input to the staff to assist in the resolution of these technical challenges within the context of the evaluation models. While these issues are treated separately from any rulemaking activity, their resolution is important to the broad issue of acceptable ECCS models when using a decay heat model based on the 1994 ANS standard.

The staff is continuing the technical work to evaluate the other potential changes to the requirements for ECCS evaluation models in 10 CFR Part 50, Appendix K, identified in SECY-01-0133.

With respect to revising 10 CFR Part 50, Appendix K, the staff recommends initiating a proposed rulemaking that would allow for voluntary licensee adoption of the most current consensus standard for decay heat power (e.g., the 1994 ANS standard) approved by the Commission, if the user-selected options required to implement the standard (e.g., operating time or fissioning isotope fractions) are approved by the staff. The rule would continue to permit use of the current decay heat requirement based on the 1971 ANS standard. This proposal is consistent with the petition for rulemaking (PRM-50-74) the staff has received from the industry.

The technical work to support changes to the evaluation model requirements will be completed in July 2002, consistent with the schedule provided in SECY-01-0133.

ECCS Reliability Requirements

In SECY-01-0133, the staff recommended changing GDC 35 to ensure an ECCS safety function reliability that is commensurate with the frequency of challenge to the ECCS safety function. This revision would permit use of more risk-informed and realistic approaches for demonstrating ECCS safety function reliability. In place of the assumptions that offsite power is not available and there is a single additional failure, two options would be offered to ensure ECCS safety function reliability:

1. ECCS safety function reliability requirements, based on risk information, would define (by generic plant groups) a minimal set of equipment required to meet an established risk guideline, OR
2. An ECCS safety function reliability requirement that is commensurate with the LOCA frequency where licensees, on a plant-specific basis, and with appropriate consideration of uncertainties, demonstrate compliance.

The staff continues to recommend the above changes to the ECCS reliability requirements.

The technical work to support the rulemaking, consistent with the technical work described in Attachment 2 of SECY-01-0133, includes:

- Establishing risk guidelines/thresholds for assessing reliable ECCS safety function.
- Determining appropriate LOCA frequencies and their distributions for this application.¹
- Estimating the conditional probability of a loss of offsite power, given a LOCA.
- Formulating generic plant groups, based on ECCS and support system configuration.

Performance of this technical work has led to the identification of technical issues that will require resolution. In particular, there are concerns over the methodology used in recent studies for calculating LOCA frequencies, over the limited data available for predicting conditional probability of LOOP given a LOCA, and over the significant differences in ECCS configuration, even of plants of similar reactor type, making plant grouping difficult. An additional technical issue that requires attention is the interface between the ECCS equipment requirements derived from the reliability analyses and the failure assumptions to be used in the ECCS thermal-hydraulic performance analyses (i.e., the single, and possibly multiple, failures that would be required to be postulated).

In SECY-01-0133, the technical work to support rulemaking with respect to changes in the ECCS reliability requirements was estimated to be completed in April 2002. Due to repercussions of the events of September 11, 2001, some of the technical work may not be completed until July 2002, particularly with respect to one or more of the technical issues identified above.

¹The determination of the LOCA frequencies is being performed as an initial task as part of the effort of redefining the spectrum of pipe break sizes, discussed below.

As discussed in SECY-01-0133, the staff plans to pursue any appropriate rulemaking with respect to changes to the ECCS reliability requirements, if approved by the Commission, after the related technical studies are completed.

Feasibility Assessment of Additional Changes to 10 CFR 50.46

The staff is continuing the feasibility study of redefining the maximum pipe break size required to be considered as part of the ECCS performance evaluation, as discussed in SECY-01-0133. In 10 CFR 50.46, LOCAs are defined as *“hypothetical accidents that would result from the loss of reactor coolant, at a rate in excess of the capability of the reactor coolant makeup system, from breaks in pipes in the reactor coolant pressure boundary up to and including a break equivalent in size to the double-ended rupture of the largest pipe in the reactor coolant system.”* The feasibility of redefining the spectrum of pipe breaks for this application is dependent on whether the staff can develop an appropriate probabilistic fracture mechanics-based methodology which addresses piping failure based on known degradation mechanisms, unknown future degradation mechanisms, and the complexities of actual leakage detection/assessment. The staff has developed plans and initiated efforts to address these considerations. A major portion of this effort involves developing and modifying several probabilistic fracture mechanics and leak-rate computer codes to reflect present knowledge of pipe failure mechanisms. Additionally, the staff is considering ways to address other failure contributors that would not be analyzed by a probabilistic piping fracture mechanics code.

The LOCA frequency analysis currently remains on schedule.

- Identification of pertinent technical issues will be completed May 2002.
- Rigorous analysis of LOCA frequencies and the uncertainties to support the redefinition of the spectrum of pipe break sizes is estimated to be complete by July 2004.

The staff notes that the industry has recently submitted a petition that, if granted, would allow the option of using an "alternative to the currently required double-ended rupture of the largest pipe in the reactor coolant system in ECCS evaluation models." Moreover, the industry has requested that the rulemaking sought by its petition be conducted in parallel with the technical work to redefine the spectrum of pipe break sizes, enabling the application of the alternative rule prior to the completion of the technical work. The staff will review this petition as well as continue to conduct the ongoing technical work and determine the most feasible course of action.

RESOURCES:

The staff resources for proceeding with rulemakings on 10 CFR 50.46 and the associated technical work, as well as for completing the recommended longer-term feasibility study on additional changes to 10 CFR 50.46, are consistent with those stated in SECY-01-0133.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections.

RECOMMENDATIONS:

In SECY-01-0133, the staff recommended that the Commission approve proceeding with rulemaking for:

- modification of the existing 10 CFR 50.46 and 10 CFR Part 50, Appendix K, and
- development of a risk-informed alternative to 10 CFR 50.46; 10 CFR Part 50, Appendix K; and GDC 35.

The staff continues to recommend the above changes to 10 CFR 50.46; 10 CFR Part 50, Appendix K; and GDC 35, including adding an option to the Appendix K evaluation model requirements to permit use of a decay heat model based on the 1994 ANS standard. The staff still plans to address the subject of uncertainty and conservatism so that proper safety focus is maintained in ECCS evaluation models that use a decay heat model based on the 1994 ANS standard, though this effort will be separate from any proposed rulemaking.

In order to improve the timeliness of these rulemakings, the staff recommends not preparing a separate rulemaking plan for each rulemaking. As stated in SECY-01-0133, the staff has been proceeding with the technical work supporting the rulemakings. The staff expects to issue draft rule language for each of the proposed changes within 12 months of Commission approval (i.e., receipt of Commission SRM) or two months after the completion of each corresponding technical study (whichever is later). Consistent with the SRM, dated August 2, 2001, the staff plans to share the draft rule language with all stakeholders in advance of the proposed rules. Sixty days after the issuance of each draft rule language, the staff will provide a schedule for the completion of each proposed rulemaking.

Because of the potential benefits of the recommended changes and the high interest by the public, the staff recommends that the Office of the Secretary release this paper to the public 10 days from the date of the paper.

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