



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

15.4.8 RADIOLOGICAL CONSEQUENCES OF A CONTROL ROD EJECTION ACCIDENT (PWR)
APPENDIX A

REVIEW RESPONSIBILITIES

Primary - Accident Evaluation Branch (AEB)

Secondary - Core Performance Branch (CPB)

I. AREAS OF REVIEW

The AEB review under this appendix covers the following areas:

1. The plant response to a control rod ejection accident.
2. The calculation of whole-body and thyroid doses at the exclusion area boundary and low population zone outer boundary due to the releases resulting from a rod ejection accident.

The purpose of the review is to assure that the plant procedures for recovery from a rod ejection accident and the plant technical specifications are properly taken into account in computing the whole-body and thyroid doses at the nearest exclusion area boundary (EAB) and low population zone (LPZ) outer boundary, and to compare the calculated doses against the appropriate guidelines.

A secondary review is performed by the CPB and the results are used by AEB in the overall evaluation of the accident analysis.

The physics and thermal-hydraulic aspects of the accident are reviewed by CPB. Verification of the applicant's calculations of the number of fuel pins experiencing departure from nucleate boiling (DNB) and the amount of fuel reaching the clad melting temperature is provided by the CPB.

II. ACCEPTANCE CRITERIA

The acceptance criteria are based on requirements of 10 CFR Part 100 as to mitigating the radiological consequences of an accident. The plant site and dose mitigating engineered safety features are acceptable with respect to the radiological consequences of a postulated control rod ejection accident if the

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USNRC STANDARD REVIEW PLAN

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Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

calculated whole-body and thyroid doses at the exclusion area (EAB) and the low population zone (LPZ) boundaries are well within the exposure guideline values specified in 10 CFR Part 100, paragraph 11 (Ref. 1). Well within is defined as 25% of the 10 CFR Part 100 exposure guideline values or 75 rem for the thyroid and 6 rem for whole-body doses.

A technical specification is required for the leak rate from the primary to secondary coolant system in the steam generators. This specification is acceptable if the calculated potential radiological consequences from the control rod ejection accident are within the exposure guidelines above.

The models for calculating the whole-body and thyroid doses are acceptable if they incorporate the appropriate conservative design basis assumptions outlined in Appendix B to Regulatory Guide 1.77 (Ref. 2) with the exception of the guidelines for the atmospheric dispersion factors (X/Q values). The acceptability of the X/Q values is determined under SRP Section 2.3.4.

III. REVIEW PROCEDURES

The reviewer selects and emphasizes specific aspects of this appendix to SRP Section 15.4.8 as are appropriate for the particular plant. The judgment which areas need to be given attention and emphasis is determined by the similarity of the information presented in the SAR or other licensing submittals to that recently reviewed on other plants and whether items of special safety significance are involved.

The detailed review of the radiological consequences of a rod ejection accident is done at the OL stage when system parameters and accident analysis results are fully developed. At the CP stage, the reviewer estimates the doses from the rod ejection accident based on the review of similar plants that have been recently reviewed. Regulatory Guide 1.77 (Ref. 2) is used in the analysis of the control rod ejection accident. In particular, Appendix B of the guide should be used in the evaluation of the radiological consequences. A loss of offsite power is assumed in the analysis. The AEB review of the accident includes the following:

1. Review of the applicant's description of the control rod ejection accident: This includes a review of the sequence of events to assure that the most severe case from the standpoint of release of fission products to the environment has been analyzed.
2. Evaluation of fuel damage: The Core Performance Branch (CPB) reviews the physics and thermal-hydraulic aspects of the accident. Verification of the applicant's calculations of the number of fuel pins reaching DNB and the amount of fuel reaching the fuel melting temperature are obtained from the CPB. The fuel melting temperature criterion used for release of large fractions of fission gases corresponds to the initiation of melting as opposed to the 280 cal/gm used as a criterion by the CPB for core disruption. It is assumed that the fission products released to the primary coolant due to fuel failure or melting are instantaneously and uniformly mixed in the primary coolant at the time of the accident.
3. Fission product release path to the environment: Two releases paths to the environment are considered independently for this accident: first, containment leakage of fission products released from the primary system to the containment; and second, leakage from the secondary system, outside

containment, following primary-to-secondary leakage in the steam generators. For releases via the containment building, 100% of the noble gases and 25% of the iodines contained in the fuel which is estimated to reach initiation of melting are assumed to be available for release from the containment. For releases through the secondary system, 100% of the noble gases and 50% of the iodines contained in the fuel which is estimated to reach initiation of melting are assumed to be released to the primary coolant.

4. The standard technical specifications for each of the three PWR vendors' NSSS include limits on the primary-to-secondary coolant leak rate. These limits are used by the staff in its dose calculation when plant-specific technical specification limits are not available.
5. Determination of the atmospheric dispersion characteristics (X/Q values). The appropriate X/Q values are determined by the assigned meteorologist in accordance with SRP Section 2.3.4.
6. Calculation of the EAB and LPZ doses. The reviewer performs an independent calculation of the thyroid and whole-body doses for the two release paths above (i.e., containment leakage and secondary system leakage outside containment).

The actual doses for the postulated accident would be a composite of the doses computed for the independent releases via the containment building and through the secondary system. However, both doses should be presented. The whole-body and thyroid doses calculated by the staff and the applicant are compared with the acceptance criteria stated in subsection II. If the doses for either release path approach the acceptance criteria, calculation of representative composite cases should be considered (the AEB branch chief should be consulted).

If the doses resulting from the releases through the secondary system exceed the acceptance criteria specified in subsection II above, then a reduction of the technical specification limit on primary-secondary system leakage should be considered. If the doses resulting from the potential releases from the primary containment exceed the specified limits, then a reduction of the pressure setpoint for actuation of the containment sprays may be considered to obtain credit for spray removal of the fission products.

IV. EVALUATION FINDINGS

The reviewer verifies that sufficient information has been provided by the applicant and that the applicant's analysis and the staff's independent calculations support conclusions such as the following, to be included with the AEB input to the staff's safety evaluation report:

The staff has reviewed the applicant's analysis of the control rod ejection accident and has performed an independent calculation of the radiological consequences following the accident. The staff concludes that the distances to the exclusion area and to the low population zone boundaries for the (insert PLANT NAME) site, in conjunction with the operation of the dose mitigating ESF systems, are sufficient to provide reasonable assurance that the calculated

radiological consequences are well within the exposure guidelines as set forth in 10 CFR Part 100, paragraph 11.

The staff's conclusion is based on (1) the staff review of the applicant's analysis of the radiological consequences, (2) the staff's independent dose calculation utilizing the recommendations of Appendix B of Regulatory Guide 1.77 and the atmospheric dispersion factors as discussed in Chapter 2 of this report, and (3) the (insert NSSS vendor) Standard Technical Specifications for the primary-to-secondary leakage in the steam generators. The staff will review the (PLANT NAME) specific technical specifications to assure that the dose guidelines stated above are not exceeded.

V. IMPLEMENTATION

The following provides guidance to applicants and licensees regarding the staff's plans for using this appendix to SRP Section 15.4.8.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides.

VI. REFERENCES

1. 10 CFR Part 100, paragraph 11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance."
2. Regulatory Guide 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors," Appendix B, "Radiological Assumptions."