

REGULATORY ANALYSIS

DRAFT REGULATORY GUIDE DG-1327 PRESSURIZED WATER REACTOR CONTROL ROD EJECTION AND BOILING WATER REACTOR CONTROL ROD DROP ACCIDENTS

1. Statement of the Problem

The staff initially provided guidance for reactivity-initiated accidents (RIA) in Regulatory Guide (RG) 1.77, "Assumptions Used for Evaluation a Control Rod Ejection Accident for Pressurized Water Reactors," in 1974. The state-of-knowledge of fuel rod performance under RIA conditions has increased significantly since publication of that guidance. The RIA empirical database has expanded from the earlier Special Power Excursion Test Reactor (SPERT) and Transient Reactor Test Facility (TREAT) research programs (which formed the basis of the initial RG 1.77 analytical limits) to include test results from the Power Burst Facility (PBF), as well as significant, more recent contributions from international research programs at the CABRI research reactor (France), Nuclear Safety Research Reactor (NSRR) (Japan), Impulse Graphite Reactor (IGR) (Russian Federation), and Fast Pulse Graphite Reactor (BGR) (Russian Federation). The research identified fuel rod burnup-related phenomena and fuel rod cladding corrosion-related phenomena not accounted for in the existing guidance.

In 2007, the staff evaluated the impact of burnup-related and cladding corrosion-related phenomena on fuel rod performance and issued interim RIA acceptance criteria and guidance in Revision 3 of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition (SRP)," specifically Section 4.2, "Fuel system design." In 2015, the staff evaluated newly published empirical data and analyses and updated the technical and regulatory basis for RIA acceptance criteria and guidance¹. It was well understood at the time the staff issued the "interim" guidance that it would be superseded when the ongoing research programs were completed and the insights from the research and operational experience needed to be captured in a Regulatory Guide and an update of the SRP.

To address the outmoded guidance in RG 1.77 the staff is considering either revising it or withdrawing it and replacing it with a new RG. Analytical limits and guidance for demonstrating compliance with applicable regulations governing reactivity limits need to be addressed. The issues being considered are updating of the guidance for analyzing a control rod ejection RIA for PWRs, and expansion of the guidance to cover a BWR control rod drop RIA. Also under consideration are thresholds for fuel cladding failure, ductile failure, brittle failure, pellet clad mechanical interaction (PCMI), and radionuclide release fractions for use in assessing radiological consequences.

2. Objective

The objective of this regulatory action is to assess the need to update NRC guidance to capture newly discovered burnup-related and cladding corrosion-related phenomena on fuel rod performance under RIA conditions. The new guidance identifies new cladding failure modes and

¹ Clifford, Paul M., Memorandum to Timothy J. McGinty, "Technical and Regulatory Basis for the Reactivity-Initiated Accident Acceptance Criteria and Guidance, Revision 1," March 16, 2015 (ADAMS Accession No. ML14188C423).

analytical thresholds, changes existing radiological source terms, and changes existing damaged core coolability analytical limits. The new guidance also expands the applicability to BWRs. The guidance provide applicants with a method to demonstrate compliance with the 10 CFR Part 50 Appendix A General Design Criteria 28 “Reactivity Limits” requirements for core coolability during reactivity accidents.

3. Alternative Approaches

The NRC staff considered the following alternative approaches:

1. Do Not Revise RG 1.77
2. Withdraw RG 1.77
3. Revise RG 1.77 to capture current state-of-knowledge and expand applicability
4. Issue new guidance and withdraw RG 1.77

Alternative 1: Do Not Revise G 1.77

Under this alternative, the NRC would neither revise nor issue additional guidance, and the current guidance would be retained. The “no-action” alternative would not address identified concerns with the current version of the regulatory guide. The only guidance remaining for stakeholders would be the guidance in Revision 3 of the SRP, which is not directed to applicants or licensees. The NRC would continue to review each application on a case-by-case basis using internal staff guidance which differs from published guidance. This includes new cladding failure modes and analytical thresholds, changes to radiological source terms, and changes to damaged core coolability analytical limits. The NRC would not expend any costs to prepare and issue new regulatory guidance. This alternative is considered the “no-action” alternative and provides a baseline condition from which any other alternatives will be assessed.

Alternative 2: Withdraw RG 1.77

Under this alternative the NRC would withdraw this regulatory guide. As with Alternative 1, it would not address identified concerns with the current version of the regulatory guide. However, in contrast to Alternative 1, Alternative 2 would eliminate the only readily available description of the methods the NRC staff considers acceptable for demonstrating compliance with the 10 CFR Part 50 Appendix A General Design Criteria 28 requirements for core coolability during reactivity accidents. The only guidance remaining for stakeholders would be the guidance in Revision 3 of the SRP, which is not directed to applicants or licensees. Withdrawal may also be misinterpreted by existing licensees as reflecting a change in NRC position on the adequacy of their licensing basis in the absence of any licensee-initiated change. Relative to Alternative 1, the NRC would expend additional costs to withdraw RG 1.77.

Alternative 3: Revise RG 1.77

Under this alternative, the NRC would revise Regulatory Guide 1.77. This revision would incorporate the latest information on fuel rod performance under RIA conditions, including newly discovered burnup-related and corrosion-related phenomena. By doing so, the NRC would ensure that the RG guidance available in this area is current, and accurately reflects the staff’s position.

The impact to the NRC would be the costs associated with preparing and issuing the regulatory guide revision. The impact to the public would be the voluntary costs associated with

reviewing and providing comments to NRC during the public comment period. However, the use of the same regulatory guide number could cause issues when maintaining a plant's licensing basis and NRC keeping track of which version a plant references. The value to NRC staff and its applicants would be the benefits associated with enhanced efficiency and effectiveness in using a common guidance document as the technical basis for license applications and other interactions between the NRC and its regulated entities. Because RG 1.77 would be updated under Alternative 3 by removing guidance, the revision may be misinterpreted by existing licensees as reflecting a change in NRC position on the adequacy of their licensing basis in the absence of any licensee-initiated change, even though the NRC would not withdraw the earlier version of the RG.

Alternative 4: Issue New Guidance and Withdraw RG 1.77

Under this alternative, the NRC would issue a new guidance document and withdraw RG 1.77. This new RG would incorporate the latest information on fuel rod performance under RIA conditions, including newly discovered burnup-related and corrosion-related phenomena. By doing so, the NRC would ensure that the RG guidance available in this area is current, and accurately reflects the staff's position.

The impact to the NRC would be the costs associated with preparing and issuing the new regulatory guide, which is the same as Alternative 3. However, as compared to Alternative 3, Alternative 4 has the additional costs to the NRC of withdrawing RG 1.77. There is no added benefit to the NRC or for existing licensees, relative to Alternative 3, for withdrawing RG 1.77. Withdrawal may be misinterpreted by existing licensees as reflecting a change in NRC position on the adequacy of their licensing basis in the absence of any licensee-initiated change. Identical to Alternative 2, the NRC would expend – relative to the base case of Alternative 1 – the additional costs to withdraw RG 1.77.

Conclusion

Based on this regulatory analysis, the NRC staff concludes that Alternative 3, issuance of a new regulatory guide without withdrawal of the current guidance (RG 1.77) is warranted. The action will enhance reactor safety by capturing the current state-of-knowledge including newly discovered burnup related and corrosion-related phenomena. The action will make available to the staff, applicants and public the most current regulatory guidance in this area and enhance the efficiency and effectiveness of the licensing process for new and existing nuclear power plants. It could also lead to cost savings for applicants by reducing the time spent by the NRC staff reviewing the application.