REGULATORY ANALYSIS

DRAFT REGULATORY GUIDE (DG)-1389
Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Power Reactors

(Proposed Revision 1 of Regulatory Guide 1.183, Revision 0, issued July 2000)

1. Introduction

This document presents the results of a regulatory analysis of the U.S. Nuclear Regulatory Commission's (NRC's) determination of whether to issue Draft Regulatory Guide (DG)-1389 to revise Regulatory Guide (RG) 1.183, Revision 0, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," issued July 2000 (Agencywide Document Access and Management System (ADAMS) Accession No. ML003716792). This analysis gives the public insight into how the NRC arrived at its proposed conclusion to revise the RG and provide updated guidance for performing evaluations of fission product releases and the radiological consequences of light water reactor (LWR) design basis accidents. The updated guidance would assist applicants and licenses in complying with the requirements of Part 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic licensing of production and utilization facilities," and would also include useful guidance for new reactor applicants under 10 CFR Part 52, "Licenses, certifications, and approvals for nuclear power plants," for performing evaluations of fission product releases and the radiological consequences of LWR design basis accidents. The specific requirements appear in 10 CFR 50.34(a)(1)(ii)(D) and 10 CFR 50.67, "Accident source term."

2. Statement of Problem

The NRC is proposing to develop and issue a revision to RG 1.183, Revision 0, to provide new reactor applicants and operating reactor licensees that adopt Title 10 of the *Code of Federal Regulations* (10 CFR) 50.67, "Accident source term," with updated guidance to support implementation of 10 CFR 50.67. The purpose of RG 1.183 is to guide applicants and licensees for light-water power reactors on acceptable applications of alternative source terms (ASTs); the scope, and documentation of associated analyses and evaluations; consideration of the impacts of analyzed risk; and the content of submittals.

The regulations cited above require nuclear power reactors to be designed with multiple barriers and safety systems to contain radioactivity during postulated accident conditions. To test the adequacy of these barriers and safety systems, applicants and licensees analyze design-basis accidents. These analyses of design-basis accidents are one of several ways licensees demonstrate (and the NRC staff verifies) that the design and location of a nuclear power plant provide reasonable assurance of adequate protection of public health and safety.

In the early 1970s, the NRC staff issued RGs for evaluating radiological consequences using the radiological source term described in Technical Information Document (TID) 14844, "Calculation of Distance Factors for Power and Test Reactor Sites," dated March 23, 1962 (ADAMS Accession No. ML021720780). Since the publication of TID-14844, significant advances have been made in understanding the timing, magnitude, and chemical form of fission product releases from severe nuclear power plant accidents. In February 1995, the NRC published NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants" (ADAMS Accession No. ML041040063), which used updated research to provide more realistic

estimates of the AST that were physically based and could be applied to the design of future light-water power reactors. In addition, the NRC determined that the analytical approach based on the TID-14844 source term would continue to be adequate to protect public health and safety for the current licensed power reactors. The NRC staff also determined that some current licensees may wish to use the NUREG-1465 source term, referred to as the AST, in analyses to support cost-beneficial licensing actions. Therefore, the NRC staff initiated several actions to provide a regulatory basis for operating reactors to use the AST in design-basis analyses. These initiatives resulted in the development and issuance of the final rule for 10 CFR 50.67 (see *Federal Register Notice* 64 FR 71990, December 23, 1999), and the subsequent issuance of RG 1.183, Revision 0 as implementing guidance for the rule.

RG 1.183, Revision 0, provides a method acceptable to the NRC staff for complying with the regulatory requirements in 10 CFR 50.67. It gives the assumptions and parameters used to model postulated radiological analyses for light-water reactors (LWRs). Since the initial issuance of RG 1.183, the NRC and the commercial nuclear industry have both gained substantial experience with the implementation of 10 CFR 50.67 and RG 1.183. In addition, new reactor applications for LWR design certification (including small modular reactors) and combined licenses have also used the guidance in RG 1.183, as far as it applies to the specific design, to show compliance with the relevant safety analysis report requirements in 10 CFR Part 52, “Licenses, certifications, and approvals for nuclear power plants.”

On October 14, 2010, the NRC issued for public comment DG-1199, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” published October 2009 (ADAMS Accession No. ML090960464). DG-1199 addressed the technical and regulatory issues known at that time and the NRC collected public comments accordingly. However, the staff never updated and published DG-1199 as a revision of RG 1.183. Although the staff did not formally respond to the public comments received on DG-1199, the staff did consider those public comments when developing DG-1389. Recently, due to both internal and external stakeholder interest, the NRC reinitiated efforts to update RG 1.183 with a new DG. Since 2020, the NRC has held multiple public meetings to seek feedback from stakeholders on updating the guidance in RG 1.183, Revision 0.

This proposed revision of the RG (Revision 1) would reflect over 21 years of experience and lessons learned since the release of RG 1.183, Revision 0. Examples include evaluating fission product releases and the radiological consequences of postulated LWR design-basis accidents, incorporation of insights from recent NRC staff reviews of license amendment requests for AST and main steam isolation valve (MSIV) leakage increases, considering nuclear power plant operating experience, collecting feedback and comments from licensees, and the evaluation of new research. In addition, this revision would provide guidance for anticipated activities associated with licensing advanced LWRs and upcoming industry initiatives (e.g., accident tolerant fuel (ATF), high-burnup fuel, and increased enrichment).

This proposed revision integrates substantial changes, including:

- a definition for the term “maximum hypothetical accident loss-of-coolant accident,” (MHA LOCA)

- transient release fractions derived from empirical data from in-pile prompt power pulse test programs and analyses from several international publications on fuel rod performance under prompt power excursion conditions,

- updated steady-state release fractions for accidents other than the MHA LOCA, based on a revision to American National Standards Institute/American Nuclear Society (ANSI/ANS) 5.4, “Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel”,

- added information to acknowledge the proposed RG may provide useful information for satisfying the radiological dose analysis requirements contained in 10 CFR Part 50 and 10 CFR Part 52 for advanced LWR design and siting,

- additional guidance for modeling boiling-water reactor (BWR) MSIV leakage,

- guidance for ATF, high-burnup fuel, and increased enrichment source term analyses,

- revised transport and decontamination models for the fuel-handling design-basis accident,

- guidance for crediting holdup and retention of MSIV leakage within the main steam lines and condenser for BWRs, and

- additional guidance on meteorological assumptions.

3. Objective

The objective of this regulatory action is to assess the need and evaluate alternatives to updating NRC guidance which is intended to provide applicants and licensees with updated guidance for performing evaluations of fission product releases and the radiological consequences of LWR design basis accidents in order for them to comply with the requirements in 10 CFR 50.34(a)(1)(ii)(D) and 10 CFR 50.67.

4. Identification and Analysis of Alternative Approaches

The NRC staff considered the following alternative approaches:

(1) Do not revise RG 1.183.
(2) Withdraw RG 1.183.
(3) Revise RG 1.183 to address current methods and procedures.

Alternative 1: Do Not Revise Regulatory Guide 1.183

Under this alternative, the NRC would not revise (or issue additional) guidance, and the current guidance would be retained. If the NRC does not take action, there would be no changes in costs or benefits to the public, licensees, or the NRC. This alternative is considered the “no-action” alternative and provides a baseline condition from which any other alternatives will be assessed. However, the “no-action” alternative would not address identified concerns with the current version of the RG.

Alternative 2: Withdraw Regulatory Guide 1.183

Under this alternative, the NRC would withdraw this RG. This would eliminate the problems identified above with the RG. However, it would also eliminate the only readily

available description of the methods the NRC staff considers acceptable for demonstrating compliance with 10 CFR 50.34(a)(1)(ii)(D) and 10 CFR 50.67. Although this alternative would be less costly than the recommended alternative in the short term, in the long term it would be more costly because removing this guidance would increase the burden for the NRC, applicants, and licensees by increasing regulatory uncertainty with respect to approved approaches and correspondingly increasing the likelihood for protracted reviews.

Alternative 3: Revise Regulatory Guide 1.183

Under this alternative, the NRC would revise RG 1.183 to include guidance for new reactors and update the RG based on knowledge gained about applying an AST to design-basis dose consequence analysis. As discussed above in Section 2, benefits realized for this revision would include incorporation of the latest information on the development of an AST, additional guidance updates for current licensees and new reactor applications, updated review practices and valuable lessons learned over the past 21 years. In addition, issuing the proposed revised guidance would (1) maintain public safety by ensuring that safety analyses use appropriate assumptions and methods, (2) reduce unnecessary regulatory burden by providing clear AST methods and assumptions for dose consequence analysis, and (3) improve efficiency and effectiveness for stakeholders. Further, the revised guidance would give applicants and licensees the updated NRC staff positions on these matters, thereby minimizing RAIs and resubmittals caused by regulatory uncertainty from either using the current guidance or withdrawing the guidance (the options discussed above). The revision would maintain public confidence by providing guidance that ensures that safety analyses are adequate to ensure that regulatory requirements are met.

The impact to the NRC would be the costs associated with preparing and issuing the revised RG. The impact to the public would be the voluntary costs associated with reviewing and providing comments to the NRC during the public comment period. The value to the NRC staff, licensees, and applicants would be the benefits associated with enhanced efficiency and effectiveness in using a common guidance document as the technical basis for AST applications and other interactions between the NRC and its regulated entities.

5. Conclusion

Based on this regulatory analysis, the NRC staff concludes that revision of RG 1.183 is warranted. This action will enhance clarity, efficiency, and effectiveness by using updated guidance on AST methods and assumptions for dose consequence analysis. In addition, this action will reduce unnecessary regulatory burden, such as minimizing RAIs and supplemental applications, while maintaining public confidence by providing guidance that helps stakeholders prepare safety analyses that are adequate to ensure that regulatory requirements are met. Cost savings to the licensee would be realized with clear regulatory guidance associated with ATF and high burnup fuel and the inclusion of holdup and retention of radionuclides in the design-basis accident analysis.