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5 REACTOR COOLANT SYSTEM AND CONNECTED SYSTEMS

Appendix A, “Design Certification Rule for the U.S. Advanced Boiling Water Reactor,” to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” constitutes the standard design certification (DC) for the U.S. Advanced Boiling Water Reactor (ABWR) design. To document the U.S. Nuclear Regulatory Commission (NRC) staff’s review supporting initial certification of the ABWR, the staff issued a final safety evaluation report (FSER) in NUREG-1503, “Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design,” in July 1994 and NUREG-1503, Supplement 1, in May 1997.

The staff is documenting its review of the GE-Hitachi Nuclear Energy (GEH or the applicant) application for renewal of the ABWR DC in Supplement 2 to NUREG-1503. Chapter 1 of this supplemental FSER describes the staff’s review process for the ABWR DC renewal. This supplemental FSER section documents the NRC staff’s review specifically related to Chapter 5, “Reactor Coolant System and Connected Systems,” Section 5.2.5, “Reactor Coolant Pressure Boundary Leakage Detection,” of the GEH Design Control Document (DCD), Revision 7. Except as modified by this supplement to the FSER, the findings made in NUREG-1503 and its Supplement 1 remain in full effect.

5.2.5 Reactor Coolant Pressure Boundary Leakage Detection

5.2.5.1 *Regulatory Criteria*

In this section the staff reviews and evaluates the applicant’s proposed change to a combined license (COL) Information Item on reactor coolant pressure boundary (RCPB) leakage detection.

In a letter dated July 20, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12125A385), the NRC staff identified 28 items for GEH’s consideration as part of their application to renew the ABWR DC. In Item No. 12, the staff asked the applicant to revise a COL Information Item to develop operating procedures to respond to prolonged low-level-reactor coolant leakage below technical specification limits. GEH proposed to revise an existing COL Information Item in the ABWR DCD to provide additional details on the procedures associated with low-level-reactor coolant leakage to be developed by COL applicants.

This change would require a COL applicant to address the issue subject to the requirements as they exist at the time the COL application is filed. Therefore, in accordance with 10 CFR 52.59(c), this design change is an “amendment,” as this term is defined in Chapter 1 of this supplement and the staff will evaluate the proposed change using the regulations in effect at renewal.

The relevant requirements of the for this area of review, and the associated acceptance criteria, are given NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants (LWR Edition),” (SRP) Section 5.2.5, “Reactor Coolant Pressure Boundary Leakage Detection,” Revision 2, issued in March 2007, and are summarized below:

- 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants,” (GDC) 30, “Quality of Reactor Coolant Pressure Boundary,” as it relates to the components which are part of the RCPB being designed, fabricated, erected, and tested to the highest quality standards practical. GDC 30 requires that means shall be provided for detecting and, to the extent practical, identifying the location of the source of reactor coolant leakage; and
- Regulatory Guide (RG) 1.45, Revision 1, “Guidance on Monitoring and Responding to Reactor Coolant System Leakage,” issued May 2008, as it relates to the selection of RCPB leakage detection systems

In a letter dated May 27, 2015 (ADAMS Accession No. ML15147A593), GEH proposed to revise an existing COL Information Item as described below.

5.2.5.2 *Summary of Technical Information*

In the certified ABWR DCD, Revision 5, COL Information Item 5.2.6.1 had stated:

Procedures and graphs will be provided by the COL applicant to operations for converting the various indicators into a common leakage equivalent (DCD Section 5.2.5.9).

GEH proposed to revise COL Information Item 5.2.6.1, “Leak Detection Monitoring,” as part of their application to renew the ABWR DCD to be consistent with updated staff guidance as follows:

The COL Applicant will include in its operating procedure development program:

- Procedures to convert different parameter indications for identified and unidentified leakage into common leak rate equivalents and leak rate rate-of-change values.
- Procedures for monitoring, recording, trending, determining the source(s) of leakage, and evaluating potential corrective action plans.
- A milestone for completing this category of operating procedures.

Based on the proposed COL Information Item above, COL applicants referencing the renewed ABWR DCD, Revision 7, will be responsible for developing a procedure to convert different parameter indications for identified and unidentified leakage, including common leak rate equivalents (volumetric or mass flow) and leak rate rate-of-change values. Typical monitoring would include parameters such as sump pump run time, sump level, condensate transfer rate, and process chemistry / radioactivity. The monitored leakage equivalent would also provide information used by the plant operators to manage the leakage and establish whether the leakage rates are within the allowable technical specifications and determine the trend (DCD Tier 2, Section 5.2.5.9).

The staff additionally confirmed that the proposed change will result in COL applicants being responsible for the development of procedures for monitoring, recording, trending, determining the source(s) of leakage, and evaluating potential corrective action plans in accordance with the latest staff guidance. An unidentified leakage rate-of-change alarm would provide operators an

early alert to initiate response actions before reaching the limiting technical specifications requirements.

GEH updated the COL Information Item listing in DCD Tier 2, Table 1.9-1 to reflect the changes described above; and the NRC staff confirmed that the applicant implemented the above changes in DCD Tier 2, Table 1.9-1 and DCD Tier 2, Section 5.2.6.1, in the ABWR DCD Revision 6 and as reflected in the ABWR DCD Revision 7.

5.2.5.3 *Technical Evaluation*

Insights from operating experience indicate that prolonged low-level unidentified reactor coolant leakage inside containment could cause corrosion and material degradation such that it could compromise the integrity of a system leading to the gross rupture of the RCPB. In RG 1.45, Revision 1, the Regulatory Position on “Operations-Related Positions,” provides guidance to address the issue and meet the requirements of GDC 30. A COL applicant should establish procedures for responding to prolonged low-level-reactor coolant system (RCS) leakage. The procedures should specify operator actions in response to prolonged low-level unidentified reactor coolant leakage conditions that exist above normal leakage rates and below the technical specification (TS) limits in order to provide operators sufficient time to take action before the TS limit is reached. These procedures would include identifying, monitoring, trending, and managing prolonged low-level leakage.

In DCD Tier 2, COL Information Item 5.2.6.1, GEH revised the leak detection monitoring for a COL applicant, such that procedures, in regard to monitoring, recording, trending, determining the source(s) of leakage, and evaluating potential corrective action plans are developed, to guide the operator’s response to RCPB leakage.

Based on the above, the staff determined that the applicant’s proposed approach is consistent with the guidance in RG 1.45, Revision 1, pertaining to management of prolonged low-level RCS leakage. Therefore, the staff finds that the applicant’s approach is acceptable.

5.2.5.4 *Conclusion*

Based on the evaluation provided in this SER section supplement, the staff concludes that the proposed amendment to the ABWR DCD associated with the revised COL Information Item meets the applicable guidance in RG 1.45, Revision 1, and therefore the requirements of GDC 30 as reviewed by the staff in accordance with SRP acceptance criteria in Section 5.2.5, Revision 2, of NUREG–0800 and therefore is acceptable.

References

1. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
2. 10 CFR Part 50, Appendix A, GDC 30, "Quality of reactor coolant pressure boundary."
3. 10 CFR Part 52, Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor."
4. 10 CFR 52.59, "Criteria for Renewal."
5. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Revision 2, Section 5.2.5, "Reactor Coolant Pressure Boundary Leakage Detection," March 2007 (ADAMS Accession No. ML070610277).
6. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
7. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," Supplement 1, May 1997 (ADAMS Accession No. ML080710134).
8. NRC, RG 1.45, "Guidance on Monitoring and Responding to Reactor Coolant System Leakage," Revision 1, May 2008 (ADAMS Accession No. ML073200271).
9. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, November 2010 (ADAMS Accession No. ML110040323).
10. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 6, Tier 1 and Tier 2, February 2016 (ADAMS Accession No. ML16214A015).
11. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 7, Tier 1 and Tier 2, December 2019 (ADAMS Accession No. ML20007E371).