

9 AUXILIARY SYSTEMS

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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 9, "Auxiliary Systems," Section 9.5.1, "Fire Protection Systems," 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.

9.5.1 Fire Protection System

9.5.1.1 Regulatory Criteria

In the ABWR DCD, Revision 7, the applicant included changes to DCD Tier 2, Section 9.5.1, "Fire Protection System," that were submitted as part of ABWR DCD, Revision 6, and associated DCD markups, which clarify the likelihood of multiple spurious actuations (also called "multiple spurious operations") due to fire in digital systems. The applicant also included changes to the ABWR DCD to require combined license (COL) applicants to follow the methodology in Nuclear Energy Institute (NEI) 00-01, "Guidance for Post Fire Safe Shutdown Circuit Analysis," Revision 2, issued June 2009, as modified by Regulatory Guide (RG) 1.189, "Fire Protection for Nuclear Power Plants," Revision 2, issued October 2009, to address multiple spurious actuations in analog systems. These changes are limited to clarifying the language in the ABWR DCD in regard to the likelihood of multiple spurious actuations due to a fire, clarifying the description of the defense-in-depth architecture of the digital systems that would prevent a spurious signal from becoming a spurious actuation, and specifying the methodologies to be used by COL applicants when addressing multiple spurious actuations in analog systems for compliance with 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," (GDC) 3, "Fire Protection," and compliance with 10 CFR 50.48, "Fire protection," as these regulations existed in 1997. The changes are ABWR DCD clarifications of the existing design and therefore, they are "modifications," as that term is defined in Chapter 1 of this FSER supplement and will correspondingly be evaluated using the regulations applicable and in effect at the initial ABWR certification.

The following regulatory requirements are relevant for this area of review:

- 10 CFR 50.48 (1997), "Fire protection," subsection (a) which requires, in part, a description of "the means to limit fire damage to structures, systems, or components important to safety so that the capability to safely shut down the plant is ensured."

- GDC 3 (1997), “Fire Protection,” as it relates to the fire protection program of the GEH ABWR standard plant design.

The staff conducted its review in accordance with NUREG–0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” (SRP), Section 9.5.1, “Fire Protection Program,” Revision 3, issued July 1981. In addition, the staff’s review followed the guidance in RG 1.189, “Fire Protection for Nuclear Power Plants,” Revision 2, with respect to multiple spurious actuations in analog systems.

9.5.1.2 *Summary of Technical Information*

In NUREG-1503, Section 9.5.1, “Fire Protection System,” the staff FSER for the originally certified ABWR DC, did not evaluate digital instrumentation & control (I&C) systems response and spurious actuations given a fire event. In the originally certified ABWR in DCD Tier 2, Section 3.13.4.2, “Fire Events,” it stated the following:

“... [S]eparation criteria are maintained during design basis fire events. Internal fire in one affected zone will not propagate to other [redundant] divisions. Smoke is removed from the affected zone. Other zones are pressurized and also vented.”

Therefore, the ABWR is designed to maintain safe shutdown capabilities following a fire in any affected zone. In addition, in DCD Tier 2, Section 9.5.1.1.7, “Spurious Control Actions,” the originally certified design DCD stated, “The probability of two spurious signals matching is essentially zero.”

In a request for additional information (RAI) 09.05.01-1, dated April 29, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15118A725), the staff requested that GEH perform an evaluation for the effects of multiple spurious operations due to a fire consistent with NEI 00-01, Revision 2, as modified in RG 1.189, Revision 2 or to propose and justify an alternative.

9.5.1.3 *Technical Evaluation*

The applicant provided responses to the staff’s RAI in letters dated July 30, 2015 (ADAMS Accession No. ML15212A762), October 29, 2015 (ADAMS Accession No. ML15302A308), April 11, 2016 (ADAMS Accession No. ML16102A344), and December 7, 2016 (ADAMS Accession No. ML16342C331), including proposed ABWR DCD markups. GEH stated that a detailed assessment of the ABWR’s vulnerability to multiple spurious operations would need to be conducted during the detailed design phase. GEH provided the following changes to DCD Tier 2, Section 9.5.1.1.7 and DCD Tier 2, Section 9.5.13.22:

- a requirement that the COL applicant provide an evaluation of the ABWR's susceptibility to Multiple Spurious Operations (MSO) in accordance with the methodology contained in NEI 00-01, Revision 2, and as modified by Regulatory Guide 1.189, Revision 2. The COL applicant will submit the results of this evaluation to the NRC for review.

The staff finds this acceptable since RG 1.189, Revision 2, endorses NEI 00-01, Revision 2.

The ABWR DCD now provides an acceptable methodology for performing the fire-induced multiple spurious analysis, whereas the original ABWR DC did not specify a methodology.

The applicant also addressed multiple spurious actuations due to fire in digital systems by proposing several changes to DCD Tier 2, Section 9.5.1.1.7. First, the applicant proposed to replace the words “probability ...is essentially zero” with “likelihood ... is miniscule.” The staff finds this acceptable because the revised ABWR DCD no longer implies a probabilistic analysis was used, which is consistent with the application of a deterministic fire protection program. In addition, the applicant proposed to insert language to clarify that along with optical fiber cabling, fire-induced spurious actuation will be considered in main control room components, remote multiplexing units (RMU), essential multiplexing system (EMS) and digital controller equipment in the control building connected via fiber-optic cable. The staff finds this acceptable because this change properly expands the spurious actuation analysis to include the digital equipment both in and outside of the main control room fire area. Lastly, the applicant proposed to insert language describing the defense-in-depth of the digital architecture that would prevent a spurious signal from becoming a spurious actuation. The digital architecture utilizes message authentication which requires the message format and sequence to be correct and to be recognized. The staff finds this acceptable because it makes use of features that are pertinent to digital systems.

The staff finds acceptable the changes described above because they clarify the language in the ABWR DCD in regard to the likelihood of multiple spurious actuations due to a fire and the description of the defense-in-depth of the digital architecture that would prevent a spurious signal from becoming a spurious actuation. In addition, the ABWR DCD specifies the NRC approved methodologies that COL applicants would use when addressing multiple spurious actuations in analog systems.

The applicant provided the necessary information in the ABWR DCD, Revision 7, which incorporated the changes described in the applicant’s response to 09.05.01-1. Therefore, Confirmatory Item 9.5.1-1 from the staff’s advanced safety evaluation report with no open items for the ABWR DC renewal is resolved and closed.

9.5.1.4 Conclusion

Based on the evaluation provided in this supplemental FSER section, the staff concludes that the changes in the ABWR DCD, Revision 7, do not alter the safety findings made in the FSER for the original ABWR DC. In addition, the changes by the applicant to address multiple spurious actuations in analog systems, are in accordance with updated guidance in RG 1.189, Revision 2. Therefore, the staff finds that the changes comply with 10 CFR 50.48 (1997) and GDC 3 (1997) and are therefore acceptable.

References

1. 10 CFR 50.48, "Fire Protection."
2. 10 CFR Part 52, Appendix A, "Design Certification Rule for the ABWR Design."
3. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants."
4. 10 CFR Part 50, Appendix A, GDC 3, "Fire Protection."
5. NRC, NUREG-1503, "Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design," July 1994 (ADAMS Accession No. ML080670592).
6. 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).
7. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Section 9.5.1, "Fire Protection Program," Revision 3, July 1981 (ADAMS Accession No. ML052350030).
8. NRC, RG 1.189, "Fire Protection for Nuclear Power Plants," Revision 2, October 2009 (ADAMS Accession No. ML092580550).
9. GEH, ABWR Standard Plant Design Certification Renewal Application Design Control Document, Revision 5, Tier 1 and Tier 2, December 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).
12. NEI 00-01, "Guidance for Post Fire Safe Shutdown Circuit Analysis," Revision 2, June 2009 (ADAMS Accession No. ML091770265).