July 16, 2010

Mr. David Czufin
Exelon
Chairman, BWR Vessel and Internals Project
Electric Power Research Institute
3420 Hillview Avenue
Palo Alto, CA 94304-1395

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION APPROVAL LETTER WITH COMMENT FOR TECHNICAL REPORT BWRVIP-14-A, "BWR VESSEL AND INTERNALS PROJECT, EVALUATION OF CRACK GROWTH IN BOILING WATER REACTOR STAINLESS STEEL REACTOR PRESSURE VESSEL INTERNALS," ELECTRIC POWER RESEARCH INSTITUE TECHNICAL REPORT 1016569 (TAC ME1509)

Dear Mr. Czufin:

By letter dated February 18, 2009, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) submitted technical report BWRVIP-14-A, "BWR Vessel and Internals Project, Evaluation of Crack Growth in BWR Stainless Steel Reactor Pressure Vessel Internals," Electric Power Research Institute (EPRI) Technical Report 1016569 for Nuclear Regulatory Commission (NRC) staff review. BWRVIP-14-A was resubmitted by letter dated May 12, 2009, to correct problems with the original electronic files (Agencywide Documents Access and Management System (ADAMS) Accession No. ML091390007).

The BWRVIP-14-A technical report was submitted as a means of exchanging information with the NRC staff for the purpose of providing a method for assessment of crack growth in BWR stainless steel shrouds and other stainless steel reactor vessel internal components. The main objectives associated with this report are: (1) to develop a generalized crack growth correlation for stainless steel materials, and (2) to formalize the method for determination of through-thickness stainless steel crack growth rates in horizontal heat affected zones in stainless steel welds. The NRC has found that the BWRVIP-14-A technical report provides an acceptable technical justification for a methodology for assessment of crack growth in BWR stainless steel shrouds and other stainless steel reactor vessel internal components.

BWRVIP-14-A presents a compilation of information from the BWRVIP-14 technical report TR105873, March 1996, as supplemented by letter dated July 28, 1997, submitted prior to an NRC initial staff safety evaluation (SE) dated June 8, 1998. BWRVIP-14-A also incorporates the NRC final SE sent in a letter dated December 3, 1999 (ADAMS Accession No. ML993430027 -- Appendix J in the BWRVIP-14-A report). The BWRVIP, in a letter dated July 11, 2000 (ADAMS Accession No. ML003732159 -- Appendix K in the BWRVIP-14-A report), responded to the NRC staff final SE. By a letter dated May 13, 2001 (ADAMS Accession No.

ML011340138-- Appendix L in the BWRVIP-14-A report), the BWRVIP provided its response to the NRC staff final SE. By letter dated July 20, 2001 (ADAMS Accession No. ML012080077-- Appendix M), NRC staff clarified its position on the BWRVIP response to the NRC staff final SE.

The NRC staff, by letter dated July 30, 2004 (ADAMS Accession No. ML042160116-- Appendix N in the BWRVIP-14-A report), issued a technical evaluation report of a draft of the BWRVIP-14-A report. The BWRVIP, in a letter dated September 12, 2005 (ADAMS Accession No. ML052580290-- Appendix 0 in the BWRVIP-14-A report), responded to the NRC staff's technical evaluation of the draft BWRVIP-14-A report. The NRC staff, in a letter dated August 22, 2007 (ADAMS Accession No. ML072340315-- Appendix P in the BWRVIP-14-A report), issued an SE for the BWRVIP response to the NRC staff issues for the draft BWRVIP-14-A report.

The NRC staff has reviewed the information in BWRVIP-14-A and has found that the technical report accurately incorporates the relevant information which was submitted by the BWRVIP in the documents noted above to support NRC staff approval of the technical report. The NRC staff found that twenty-six revisions were made in the production of BWRVIP-14-A. These revisions are discussed in detail below.

The first revision was that Sections 1.1 and 3.5 4 of BWRVIP-14-A were revised to provide Appendix Q, which includes information regarding cracking (no through wall) in core shrouds in the United States. The NRC staff finds this revision acceptable because the updates requested were provided.

The second revision was that Section 1.2 was revised to indicate that crack growth model is valid in the through-wall depth direction, and the model is applicable for materials exposed to a neutron fluence value equal to or less than 5×10^{20} n/cm^2 (E > 1 MeV). The NRC staff finds this revision acceptable because it is consistent with the crack growth model in the BWRVIP-14-A report.

The third revision was that Section 2.0 of BWRVIP-14-A was revised to indicate the sources of second database were: (1) laboratory data, and (2) crack arrest verification systems. The NRC staff finds this revision acceptable because it provides valuable information regarding the crack growth data.

The fourth revision was that Section 3.3 of BWRVIP-14-A was revised to include equations that are valid for the best-fit correlation model and the 95th percentile model. The NRC staff finds this revision acceptable because it provides useful information regarding the development of the models.

The fifth revision was that Figure 3-9 in Section 3.5 of BWRVIP-14-A was revised to include changes made to Figure 3-9 and revised K distribution in Section 5.0. Additional plant data was added to Figure 3-9 for completeness. The NRC staff finds this revision acceptable because it provides updated information regarding the model prediction and field data on crack growth rates.

The sixth revision was that Section 4.1 of BWRVIP-14-A was revised to include maximum axial operating stress in the shroud. The NRC staff finds this revision acceptable because the information requested was provided.

The seventh revision was that Section 4.6 of BWRVIP-14-A was revised to include Appendix O with the results of the finite element analysis (FEA). The results of the FEA provide justification that the residual stress distribution is applicable to both the shell-to-shell and shell-to-ring welds. The NRC staff finds this revision acceptable because the information requested was provided.

The eighth revision was that Section 4.7 of BWRVIP-14-A was revised to address localized residual stresses developed during welding. The NRC staff finds this revision acceptable because the information requested was provided.

The ninth revision includes deletion of reference to Bamford and Buchalet stress intensity factor (K) formulation and the tenth revision includes the addition of the Cheng and Finnie K solution to Section 5.1 of BWRVIP-14-A. The NRC staff finds these revisions acceptable because information requested was provided.

The eleventh revision was that Section 5.2 of BWRVIP-14-A was revised to show new K formulations by Cheng and Finnie which were presented in response Appendix B. The NRC staff finds this revision acceptable because information requested was provided.

The twelfth revision was that Section 4.7 of BWRVIP-14-A was revised to include FEA results which provide justification that the K distribution is applicable to both shell-to-shell and shell-to-ring welds. The NRC staff finds this revision acceptable because the information requested was provided.

The thirteenth revision was that Section 5.2 of BWRVIP-14-A was revised to include a discussion of localized stresses and their effect on K distribution. This revision is consistent with new Section 4.7 and newly revised Section 5.2. The NRC staff finds this revision acceptable because the information requested was provided.

The fourteenth revision was that Section 6.1 of BWRVIP-14-A was revised to include three evaluations: (1) K independent approach, (2) K dependent approach, and (3) K and environment --electro chemical potential (ECP) and conductivity dependent approach. The NRC staff finds this revision acceptable because the information requested was provided.

The fifteenth revision was that Sections 6.1.1, 6.1.2 and 6.1.3 were revised to indicate that three evaluation approaches are applicable to reactor coolant system (RCS) water with conductivity up to 0.3 μS/cm. The NRC staff finds this revision acceptable because it addresses the applicability of the evaluations with respect to RCS water chemistry.

The sixteenth revision was that Section 6.1 was revised to indicate that K- independent crack growth rates are only applicable to components with fluence less than 5×10^{20} n/cm^2 (E > 1 MeV). The NRC staff finds this revision acceptable because the information requested was provided.

The seventeenth and the eighteenth revisions were related to Section 6.2, which includes a new plant-specific example addressing the revised K distribution presented in Section 5.2 of the report for various stresses. The NRC staff finds these revisions acceptable because the information requested was provided.

The nineteenth revision was that Section 6.3 was added to provide comparison between analytical crack growth predictions and field data. The NRC staff finds this revision acceptable because the information requested was provided.

The twentieth revision was that the text in Appendix H (page H-25) was revised to provide information on stresses in the core shroud welds. The NRC staff finds this revision acceptable because the information requested was provided.

The twenty-first and twenty-second revisions were that Sections 7.0 and 8.0 were updated to maintain consistency with all the changes made in the revised report. The NRC staff finds these revisions acceptable as they are consistent with the changes made in the report.

The twenty-third revision was the addition of new Appendices J, K, L, M, N, O, P, Q and R. The NRC staff finds this revision acceptable as it provides valuable information on the various correspondences between the BWRVIP and the NRC staff, and the NRC staff's SEs for the BWRVIP-14 and BWRVIP-14-A reports.

The twenty-fourth revision was that the Executive Summary was revised to reflect the changes made to the report. The NRC staff finds this revision acceptable as it is consistent with the changes made in the report.

The twenty-fifth revision was that Section 6.0 was revised to indicate the limitations on the applicability of the crack growth rate (CGR) evaluations in high conductivity RCS conditions. The NRC staff finds this revision acceptable as it provides adequate guidelines in applying CGR evaluations in RCS water with conductivity equal to or less than 0.3 micro-Siemens/cm.

The twenty-sixth revision was that Sections 1.0 and 6.0 were revised to clarify that CGRs for RCS water with hydrogen water chemistry (HWC) are also applicable when noble metal chemical application (NMCA) is used. The NRC staff finds this revision acceptable as it explains the applicability of CGRs in both HWC and HWC/NMCA.

Based on the discussion above, the NRC staff has determined that the BWRVIP-14-A technical report is acceptable. Please contact Jonathan Rowley of my staff at (301) 415-4053 if you have any further questions regarding this subject.

Sincerely,

/RA/

Thomas B. Blount, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 704

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