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2007-011 _____ BWR Vessel & Internals Project (BWRVIP)

January 10, 2007

Document Control Desk
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852

Attention: John Honcharik

Subject: Project 704 – BWRVIP Response to NRC Comments and Suggestions on BWRVIP-145

References: Letter, M.A. Mitchell (U.S. NRC) to W.A. Eaton (Entergy), "Comments and Suggestions Regarding the BWRVIP-145 Report: BWR Vessel and Internals Project, Evaluation of Susquehanna Unit 2 Top Guide and Core Shroud Material Samples Using RAMA Fluence Methodology (TAC No. MD0043)," May 12, 2006.

Enclosed are five (5) copies of the BWRVIP response to the NRC comments and suggestions regarding the BWRVIP report entitled "BWRVIP-145: BWR Vessel and Internals Project, Evaluation of Susquehanna Unit 2 Top Guide and Core Shroud Material Samples Using RAMA Fluence Methodology" that was transmitted to the BWRVIP by the NRC letter referenced above.

If you have any questions on this subject please contact Bob Geier (Exelon, BWRVIP Assessment Committee Technical Chairman) by telephone at 630.657.3830 or by email at robert.geier@exeloncorp.com

Sincerely,

William A Eaton

William Eaton
Entergy Operations
Chairman, BWR Vessel and Internals Project

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BWRVIP Response to NRC Comments and Suggestions on BWRVIP-145

Items from the NRC Comments and Suggestions on BWRVIP-145 are repeated below verbatim followed by the BWRVIP response to that item

Comment #1

The staff noted that the subject of this report fills a gap in existing methods and data for reactor internals dosimetry and fluence. Significant difficulties were experienced in using the conventional discrete ordinates method in calculating the fluence values for components away from the middle plane. However, the RAMA fluence methodology seems to be able to overcome such problems albeit with increased effort.

Response to Comment #1

The combination of three-dimensional particle transport and flexible geometry modeling in the RAMA Fluence Methodology is well suited to determining the neutron fluence in components at locations away from the core mid-plane. Several pre-processing and post-processing tools are included in the Methodology to facilitate the generation and evaluation of complex fluence analysis models. These features make RAMA well suited to applications involving reactor system components that lie outside the traditional mid-plane analysis region.

Comment #2

The staff is pleased to see that the BWRVIP will follow this effort with thermal fluxes for the RPV internals. This is another void that needed to be filled.

Response to Comment #2

Traditional neutron fluence evaluations have utilized cross-section sets and modeling techniques that are specifically developed for use in predicting high energy neutron fluence in order to characterize material embrittlement resulting from neutron irradiation. Additional considerations, such as the impact of helium production on weldability, requires an accurate assessment of the low energy neutron spectrum. BWRVIP recognizes that thermal fluence evaluations introduce additional cross-section and modeling issues beyond those encountered in fast neutron evaluations. As a result, effort is underway to investigate these issues and, thereby, to extend the capabilities of the RAMA fluence methodology to include thermal neutron applications.

Suggestion #1

The report correctly states that no specific guidelines have been established for the acceptable prediction bias and uncertainty for the RPV shroud and top guide components. There are two reasons for this lack of acceptance criteria, which include: (1) the difficulty of establishing feasible uncertainties and (2) the spectrum of potential uses.

The staff agrees that RAMA seems to have overcome some of these difficulties. However, the staff recommends that the BWRVIP propose acceptance criteria for the fluence bias and uncertainty, as related to the intended purpose of the measurements and/or calculations.

Response to Suggestion #1

It is desirable to have established acceptance criteria for the fluence bias and uncertainty of vessel components. Regulatory Guide 1.190 provides uncertainty acceptance criteria and an acceptable calculational methodology for application to reactor pressure vessels. The safety significance of some internal components is commensurate with that of the vessel. Therefore, in the absence of additional measurement comparisons, and in view of the observed capability of the RAMA Fluence Methodology to predict the fast neutron fluence in the shroud and top guide, BWRVIP recommends that the acceptance criteria proposed in RG 1.190 should be equally applied to the shroud and top guide.

Suggestion #2

The staff recommends that the BWRVIP analyze a number of existing shroud measurements to form a reference or benchmarking database and add this information to the BWRVIP-145 report.

Response to Suggestion #2

Fluence benchmarks of the type documented in BWRVIP-145 are very difficult and expensive to conduct. The selection of the plant, location and number of samples, availability of detailed operating history, etc are examples of critical criteria that need to be carefully considered when performing such a fluence benchmark. The cost of this project was ~$650K and involved ~3 years of planning and execution.

Samples are not routinely removed from BWR internals. BWRVIP is aware of only two other similar benchmarks using samples removed from core shrouds. In both cases the DORT fluence methodology was utilized. Notwithstanding the limited number of quality component fluence benchmarks, if additional component activation measurements become available in the future, BWRVIP will consider including the comparison data in the fluence benchmark database.

Suggestion #3

Inspection of the results listed in the tables of Sections 5 and 6 of the BWRVIP-145 report indicates a calculation to measurement (C/M) bias towards the higher calculated values. In addition to the observations discussed in Section 2.3 of the BWRVIP-145 report, the staff recommends that the BWRVIP consider adding the following observations to the report: (a) the spectral coverage for iron and nickel (that are represented in the measurements) is limited and (b) the addition of measurements to include copper and/or titanium could establish or eliminate the apparent bias.

Response to Suggestion #3

The spectral range of the iron and nickel is, indeed, limited. It is likely that including other reactions with varying spectral ranges would establish, if not eliminate, the apparent bias in the comparison to measurements. It would be desirable to have additional activation measurements for other fast neutron reactions, such as titanium and copper. However, the large time interval since the irradiation of the samples, coupled with the small quantity of titanium in the samples, makes it unlikely that the titanium reaction products are present in sufficient quantity to obtain reliable activity measurements. Limited amounts of copper are present in the samples, however, the resulting quantity of cobalt-60 produced by the fast reaction is overwhelmed by production from the thermal reaction of the trace amounts of cobalt present in the samples. As a result, it is not feasible to further establish the apparent bias using these measurement samples.