ATTACHMENT (1)

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION DATED OCTOBER 15, 2008 - MEASUREMENT UNCERTAINTY RECAPTURE POWER UPRATE

RAI 1:

Section IV.5 of the submittal lists the extended license surface fluence for Calvert Cliffs, Unit 1 as 5.09 x l0^{19} n/cm^2 (E > 1.0 MeV) and for Calvert Cliffs, Unit 2 as 5.74 x 10^{19} n/cm^2 (E > 1.0 MeV). The corresponding surface fluence values, cited in the safety evaluation report dated December 1999 for the extended license renewal application for Calvert Cliffs, were 4.95 x 10^{19} n/cm^2 (E > 1.0 MeV) and 5.77 x 10^{19} n/cm^2 (E > 1.0 MeV) for Unit Nos. I and 2, respectively. Please explain the discrepancies between these numbers. In addition, please clarify whether the surface fluence values cited were at the wetted surface or at the clad to base metal interface.

CCNPP Response:

The fluence values cited are at the clad-vessel interface and are specified at end-of-extended life (EOEL). However, the basis for defining EOEL has changed over time. In 1999, EOEL for Unit 1 was defined as End-of-Cycle 31 in 2034 at 16942.405 effective full power day (EFPD), which yielded a clad-vessel interface fluence value of 4.95E+19 n/cm^2. The following year the EOEL for Unit 1 was defined as 48 effective full power year (EFPY) (17520 EFPD), which yielded a clad-vessel interface fluence value of 5.09E+19 n/cm^2.

In 1999, EOEL for Unit 2 was defined as End-of-Cycle 31 at 17614.691 EFPD, which yielded a clad-vessel interface fluence value of 5.77E+19 n/cm^2. The following year the EOEL for Unit 2 was defined as 48 EFPY (17520 EFPD), which yielded a clad-vessel interface fluence value of 5.74E+19 n/cm^2.

RAI 2:

Section IV.5 of the submittal lists the extended license fluence at the three-quarter thickness of the reactor vessel (RV) wall (3/4T) location for Calvert Cliffs, Unit 1 as 6.09 x 10^{18} n/cm^2 (E > 1.0 MeV) based on the RV surface fluence of 5.09 x 10^{19} n/cm^2 (E > 1.0 MeV). This 3/4T fluence value does not compare well to the NRC staff's independently calculated value of 1.08 x 10^{19} n/cm^2 (E > 1.0 MeV) based on an RV wall thickness from the staffs Reactor Vessel Integrity Database (RVID) of 8.625". The values for Calvert Cliffs, Unit 2 and all uprated values were similarly inconsistent with the NRC staffs independent calculation. Please explain how you determined the values cited in the application for the 3/4T locations and, if inconsistent, submit new values.

CCNPP Response:

For Calvert Cliffs Unit 1, the current clad-vessel interface and 3/4T fluence values were derived from Reference (1) which was submitted to the Nuclear Regulatory Commission (NRC) via Reference (2). The fast fluxes (E > 1.0 MeV) at the vessel-clad interface and at the 3/4T location for cycles 1-10 (4039.755 EFPD) were determined to be 5.63E+10 and 0.64E+10 n/cm^2-sec, respectively. Guide tube flux suppressors were inserted into selected assemblies in cycles 11-12 (1137.906 EFPD) and the vessel-clad interface and the 3/4T location fluxes were reduced to 2.27E+10 and 2.807E+09 n/cm^2-sec, respectively. The 24-month low fluence loading patterns with no guide tube flux suppressors were utilized from cycles 13 to end-of-life defined as 48 EFPY (12342.34 EFPD) with revised fluxes of 2.72E+10 and 3.364E+09 n/cm^2-sec at the clad-vessel interface and at the 3/4T location. Thus,

Fluence at clad-vessel interface
= (5.63E+10 * 4039.755 + 2.27E+10 * 1137.906 + 2.72E+10 * 12342.34) * 24 * 3600
= 5.09E+19 n/cm^2

Fluence at 3/4T location
= (0.64E+10 * 4039.755 + 2.807E+09 * 1137.906 + 3.364E+09 * 12342.34)*24*3600
= 6.09E+18 n/cm^2

For Calvert Cliffs Unit 2, the current clad-vessel interface and 3/4T fluence values were derived from Reference (3) which was submitted to the NRC via Reference (4). The fast fluxes (E > 1.0 MeV) at the vessel-clad interface and at the 3/4T location for cycles 1-9 (4004.041 EFPD) were determined to be 4.15E+10 and 4.57E+09 n/cm^2-sec, respectively. The 24-month low fluence loading patterns were utilized from cycles 10 to end-of-life defined as 48 EFPY (13515.96 EFPD) with revised flux values of 3.69E+10 and 4.07E+09 n/cm^2-sec at the clad-vessel interface and at the 3/4T location. Thus,

Fluence at clad-vessel interface
= (4.15E+10 * 4004.041 + 3.69E+10 * 13515.96) * 24 * 3600
= 5.74E+19 n/cm^2

Fluence at 3/4T location
= (4.57E+09 * 4004.041 + 4.07E+09 * 13515.96) * 24 * 3600
= 6.33E+18 n/cm^2

The determination of the RV and surveillance capsule flux and fluence values was accomplished through the simultaneous consideration of neutron dosimetry measurements and analytically derived flux spectra. The Unit 1 263° and 97° surveillance capsules were extracted in 1979 and 1992, while the Unit 2 263° and 97° surveillance capsules were extracted in 1982 and 1993. The methodology employs explicit modeling of the RV and internals in R-theta (midplane) and R-Z coordinates and uses an average core power distribution in the discrete ordinates transport code DOTIV version 4.3. DOTIV uses the discrete ordinates method of solution of the Boltzmann transport equation and has multi-group and asymmetric scattering capability. The code parameters are specified as P_3 order of scattering, S_8 quadrature, and 47 neutron energy groups. For more detail, refer to the above mentioned Babcock and Wilcox (B&W) reports.

Regulatory Guide 1.99, Revision 2 "Radiation Embrittlement of Reactor Vessel Materials" states that the neutron fluence at any depth in the vessel wall, f(10^{19} n/cm^2, E > 1 MeV) is determined as follows:

$f = f_{surf} * \exp(-0.24 * x)$ where x is in inches.

x = 8.625" * 0.75 for the 3/4T location

Per Reference (5), the above equation is a "dpa equivalent" formula, not a fluence formula. Dpa attenuation through an 8" vessel wall is less than the attenuation of fast fluence by a factor of 2.06.

Thus, for Unit 1 a vessel-clad fluence of 5.09E+19 n/cm^2 yields a "3/4T dpa equivalent fluence" of 1.08E+19 n/cm^2 (5.09E19*exp(-0.24*8.625*0.75)) and an actual 3/4T fluence of 5.23E+18 n/cm^2 (5.09E19*exp(-0.24*8.625*0.75)/2.06) which is slightly less than the more exact value of 6.09E+18 n/cm^2 calculated above. For Unit 2 a vessel-clad fluence of 5.74E+19 n/cm^2 yields a "3/4T dpa equivalent fluence" of 1.22E+19 n/cm^2 (5.74E19*exp(-0.24*8.625*0.75)) and an actual 3/4T fluence of 5.90E+18 n/cm^2 (5.74E19*exp(-0.24*8.625*0.75)/2.06) which is slightly less than the more exact value of 6.33E+18 n/cm^2 calculated above.

Note that surveillance capsule withdrawal schedules are determined via American Society for Testing and Materials (ASTM) E185. Section 8.2.1 of ASTM E185-82 states that "The neutron flux density, neutron energy spectrum, and neutron fluence of the surveillance specimens and the corresponding maximum values for the RV shall be determined in accordance with the guidelines in ASTM E482 and Recommended Practice E560." The methodology of ASTM E482 is the methodology utilized in References (1) and (3). Thus, the 1/4T and 3/4T fluence values listed in Section IV.5 of Calvert Cliffs Appendix K submittal, which are used to determine surveillance capsule withdrawal schedules, are correct.

Also note that for applications other than surveillance capsule withdrawal schedules (e.g., low temperature over pressure limits), the Regulatory Guide 1.99 definition of fluence inside the RV is used for conservatism, since the regulatory guide definition results in a more conservative adjusted reference temperature value.

RAI 3:

Confirm that the RV surveillance capsule withdrawal schedules for Calvert Cliffs, Units 1 and 2 still meet the requirements of 10 CFR Part 50, Appendix H by demonstrating compliance with the guidance in the edition of ASTM E185 which is applicable to your facility after accounting for the effects of the uprate.

CCNPP Response:

Separate from Calvert Cliffs' submittal for this Measurement Uncertainty Recapture (MUR) power uprate in Reference (6), Calvert Cliffs also has submitted, in Reference (7), a proposed revision to its schedule for withdrawal of reactor vessel material surveillance capsules for Units 1 and 2. The values contained in Reference (7) did not include expected MUR power uprate values. Approval of this request is expected in January 2009. Since we expect approval shortly, it was felt it best to respond to this request for additional information using the revised surveillance capsule removal schedule rather than the site's existing surveillance capsule removal schedule.

As indicated in Reference (7), the proposed surveillance capsule removal schedule is in compliance with ASTM E185-82 withdrawal schedule guidance. American Society for Testing and Materials E185-82 is consistent with, but more specific than, the guidance provided in ASTM E185-70 which is the applicable standard to which the Calvert Cliffs reactor vessels' surveillance program is required to conform. This remains the case even when the impact of the MUR power uprate is factored in as well.

Table 3A below shows both Calvert Cliffs Unit 1's proposed surveillance capsule withdrawal schedule as submitted in Reference (7) and the fluence values expected with the effect of the MUR power uprate included in the calculations. It is important to note that the impact of the MUR power uprate is minimal and does not change the withdrawal schedule.

Table 3A: Unit 1 Surveillance Capsule Withdrawal Schedule					
Capsule Azimuthal Position (degrees)	Target Fast Neutron Fluence (xE19 n/cm^2)		Projected Fast Neutron Fluence (xE19 n/cm^2)		Projected End of Cycle (EOC) Date
	Reference (7) Submitted Values	Values with MUR Power Uprate Included	Reference (7) Submitted Values	Values with MUR Power Uprate Included	
263	0.62	N/A	0.62	N/A	Removed-1979
97	2.64	N/A	2.64	N/A	Removed-1992
104	3.06	3.08	3.12	3.12	2010
83	5.26	5.28	5.33	5.34	2020
277	6.59	6.62	6.59	6.62	2032
284	Standby	Standby	Standby	Standby	

Similarly, Table 3B below shows both Calvert Cliffs Unit 2's proposed surveillance capsule withdrawal schedule as submitted in Reference (7) and the fluence values expected with the effect of the MUR power uprate included in the calculations. It is important to note that, as with Unit 1, the impact of the MUR power uprate is minimal and does not change the withdrawal schedule.

Table 3B: Unit 2 Surveillance Capsule Withdrawal Schedule					
Capsule Azimuthal Position (degrees)	Target Fast Neutron Fluence (xE19 n/cm^2)		Projected Fast Neutron Fluence (xE19 n/cm^2)		Projected EOC Date
	Reference (7) Submitted Values	Values with MUR Power Uprate Included	Reference (7) Submitted Values	Values with MUR Power Uprate Included	
263	0.806	N/A	0.806	N/A	Removed-1982
97	1.85	N/A	1.85	N/A	Removed-1993
104	3.24	3.27	3.23	3.23	2011
83	6.16	6.21	6.30	6.34	2025
277	7.46	7.50	7.46	7.50	2033
284	Standby	Standby	Standby	Standby	

RAI 4:

The submittal provides no information regarding your RV internals structural evaluation. Table Matrix-1 of Nuclear Regulatory Commission RS-001, Revision 0, "Review Standard for Extended Power Uprates," provides the staff's basis for evaluating the potential for extended power uprates to induce aging effects on RV internals. Depending on the magnitude of the projected RV internals fluence, Table Matrix-1 may be applicable to the MUR application. The Industry has established, among other aging issue guidelines, the neutron irradiation-related thresholds for irradiation-assisted stress-corrosion cracking (IASCC) for various pressurized-water reactor (PWR) RV internal components and is working on inspection guidelines for them. Please confirm that you have participated in the industry's initiatives on age-related degradation of PWR RV internals and will implement the industry criteria and inspection guidelines on *this issue when they are approved by the NRC by factoring them into your RV internal inspections as appropriate.*

CCNPP Response:

Material susceptibility to IASCC has been observed to occur at fluence levels as low as $1x10^{21}$ n/cm^2. The increase in the fluence exposure to RV internals as the result of the MUR uprate will be factored into Calvert Cliffs RV internals program. The small fractional increase in fluence levels as a result of the MUR uprate is not expected to have significant additional impact on RV internals components. Calvert Cliffs is actively following industry work in the RV internals age-related degradation area. We currently have both site and corporate representation on Electric Power Research Institute Materials Reliability Program (MRP) groups and the Pressurized Water Reactors Owners Group Materials Subcommittee involved in this work. Materials Reliability Program-227, Revision 0, PWR Internals Inspection and Evaluation Guidelines, is scheduled for approval December 2008 and will provide guidelines for the development of a RV internals inspection plan. An industry Material Degradation Management Program (Nuclear Energy Institute 03-08) supported requirement to develop a RV Internals Inspection Program Plan, meeting the MRP-227 guidelines is also expected. Guidelines from these industry documents will be incorporated into the development of Calvert Cliffs RV internal inspection program. The development of the RV internal inspection program is included as part of Calvert Cliffs license renewal implementation program plans.

REFERENCES

(1) B&W Nuclear Service Company, BAW-2160, June 1993, Analysis of the Calvert Cliffs Nuclear Power Plant Unit No. 1 Reactor Vessel Surveillance Capsule Withdrawn from the 97° Location of the Beltline Region

(2) Letter from Mr. R. E. Denton (BGE) to Document Control Desk (NRC), dated June 22, 1993, Analysis of the Calvert Cliffs Nuclear Power Plant Unit No. 1 Reactor Vessel Surveillance Capsule Withdrawn from the 97° Location

(3) B&W Nuclear Service Company, BAW-2199, February 1994, Analysis of the Calvert Cliffs Nuclear Power Plant Unit No. 2 Reactor Vessel Surveillance Capsule Withdrawn from the 97° Location of the Beltline Region"

(4) Letter from Mr. R. E. Denton (BGE) to Document Control Desk (NRC), dated March 18, 1994, Analysis of the Calvert Cliffs Unit No. 2 Reactor Vessel Surveillance Capsule Withdrawn from the 97°F Location

(5) ASTM STP 909, "Basis for Revision 2 of the USNRC Regulatory Guide 1.99, Radiation Embrittlement of Nuclear Reactor Pressure Vessel Steels: An International Review," Second Volume, 1986, pp. 149-162

(6) Letter from Mr. D. R. Bauder (CCNPP) to Document Control Desk (NRC), dated August 29, 2008, License Amendment Request: Appendix K Measurement Uncertainty Recapture – Power Uprate Request

(7) Letter from Mr. M. J. Gahan (CCNPP) to Document Control Desk (NRC), dated July 29, 2008, Revision to Reactor Vessel Surveillance Capsule Withdrawal Schedule