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10 CFR 50
10 CFR 51
10 CFR 54

RS-14-098

April 14, 2014

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Response to NRC Request for Additional Information, Set 17, dated March 20, 2014, related to the Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2, License Renewal Application

References:

1. Letter from Michael P. Gallagher, Exelon Generation Company LLC (Exelon) to NRC Document Control Desk, dated May 29, 2013, "Application for Renewed Operating Licenses."

2. Letter from Lindsay R. Robinson, US NRC to Michael P. Gallagher, Exelon, dated March 20, 2014, "Request for Additional Information for the Review of the Byron Nuclear Station, Units 1 and 2, and Braidwood Nuclear Station, Units 1 and 2, License Renewal Application, Set 17 (TAC NOS. MF1879, MF1880, MF1881, and MF1882)

In the Reference 1 letter, Exelon Generation Company, LLC (Exelon) submitted the License Renewal Application (LRA) for the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 (BBS). In the Reference 2 letter, the NRC requested additional information to support the staffs' review of the LRA.

The Enclosure contains the response to this request for additional information.

There are no new or revised regulatory commitments contained in this letter.

If you have any questions, please contact Mr. Al Fulvio, Manager, Exelon License Renewal, at 610-765-5936.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 4-14-2014

Respectfully,

Michael P. Gallagher
Vice President - License Renewal Projects
Exelon Generation Company, LLC

Enclosure: Response to Request for Additional Information

cc: Regional Administrator – NRC Region III
NRC Project Manager (Safety Review), NRR-DLR
NRC Project Manager (Environmental Review), NRR-DLR
NRC Senior Resident Inspector, Braidwood Station
NRC Senior Resident Inspector, Byron Station
NRC Project Manager, NRR-DORL-Braidwood and Byron Stations
Illinois Emergency Management Agency - Division of Nuclear Safety

Enclosure

Byron and Braidwood Stations (BBS), Units 1 and 2
License Renewal Application

Response to Request for Additional Information

RAI B.2.1.7-7

RAI B.2.1.7-7

Applicability:

Byron Nuclear Station and Braidwood Nuclear Station, all units

Background:

The applicant's pressurized-water reactor (PWR) Vessel Internals aging management program implements the guidance of Materials Reliability Program (MRP)-227-A, "Pressurized Water Reactor (PWR) Internals Inspection and Evaluation Guidelines," to manage the aging effects of reactor vessel internals (RVIs) components.

Applicant/Licensee Action Item No.1 of MRP-227-A states that each applicant/licensee shall refer, in particular, to the assumptions regarding plant design and operating history made in the failure modes, effects, and criticality assessment (FMECA) and functionality analyses for reactors of their design (i.e., Westinghouse, CE, or B&W) which support MRP-227 and describe the process used for determining plant-specific differences in the design of their RVI components or plant operating conditions, which result in different component inspection categories. The applicant/licensee shall submit this evaluation for NRC review and approval as part of its application to implement the approved version of MRP-227. The applicant provided its response to Applicant/Licensee Action Item No.1 in license renewal application (LRA) Appendix C.

Issue:

The staff noted that the applicant's response to Applicant/Licensee Action Item No.1 did not adequately address the three key variables at the applicant's site that feed into the screening process for aging degradation (stress, neutron fluence, and temperature) and determine how these variations, if any, would ultimately affect the aging management recommendations.

The staff's concern was addressed generically with the industry as documented in the following documents: "Meeting Summary EPRI-Westinghouse," January 22-23, 2013, (ADAMS Accession No. ML13042A048) and "Summary of Telecom with EPRI and Westinghouse Electric Company," on February 25, 2013 (ADAMS Accession No. ML13067A262).

The staff also noted that by letter dated October 14, 2013, the MRP issued EPRI Letter MRP 2013-025. The staff noted that the purpose of this letter was to provide an MRP-227-A related guidance document for MRP members to use in developing reactor internals related information for plant-specific inspection programs. Specifically, the enclosure was developed to provide utilities with the basis for a plant to respond to the NRC's request for additional information (RAI) to demonstrate compliance with the basic technical applicability assumptions in MRP-227-A for originally licensed and uprated conditions.

Request:

1. Cold-worked Materials - Do the units have non-weld or bolting austenitic stainless steel components with 20 percent cold work or greater: and if so, do the affected components have operating stresses greater than 30 ksi? (The staff notes that, if both conditions are true, then additional components may need to be screened in for stress corrosion cracking).

2. Fuel Design or Fuel Management - Does the plant have atypical fuel design or fuel management that could render the assumptions of MRP-227-A, regarding core loading/core design, non-representative for that plant?

Exelon Response:

1. Exelon has currently contracted the reactor vessel internals (RVI) supplier to perform a detailed review of the Byron and Braidwood Stations' RVI fabrication records to identify any non-welded or bolting stainless steel components that may have been cold worked greater than 20 percent and subject to operating loads greater than 30 ksi. This detailed review will be completed and the results communicated to the NRC by the end of October 2014.

2. Byron and Braidwood Station, Units 1 and 2, fuel design and fuel loading were evaluated against the criteria provided in EPRI letter MRP 2013-025, "MRP-227-A Applicability Template Guideline", Attachment 1, to determine if the units used atypical fuel designs or fuel management that could render the assumptions of MRP-227-A, regarding loading/core design, non-representative for that unit. Three (3) boundaries were explored in developing the criteria provided in MRP 2013-025, radial boundary, upper axial boundary, and lower axial boundary. To meet the radial boundary criteria, it is necessary for the average core power density to be less than 124 watts/cm^3 and the heat generation "figure of merit," as defined in MRP 2013-025, to be less or equal to 68 watts/cm^3. To meet the upper axial boundary criteria, it is necessary that the distance between the top of the active fuel and the upper core plate be greater than 12.2 inches and the average core power density be less than 124 watts/cm^3. To meet the lower axial boundary criteria, it is only necessary to meet the radial boundary and upper axial boundary criteria.

   Radial Boundary Evaluation

   Historically, low-leakage, also known as in-out (i.e., no fresh fuel in peripheral locations) core loading patterns have been used in Byron and Braidwood Station, Units 1 and 2, since the early 1990s.

   The average core power density for all past Byron and Braidwood, Units 1 and 2, operating cycles was less than 124 watts/cm^3. A summary of the average core power densities is provided below. The change in average power density is associated with changes in rated power implemented in the 2000 and 2014 timeframe.

Average Core Power Density

Cycle	Criteria	Core Power Density
Byron Unit 1 Cycle 1 through Cycle 10 Byron Unit 2 Cycle 1 through Cycle 9 Braidwood Unit 1 Cycle 1 through 8 Braidwood Unit 2 Cycle 1 through 8	<124 watts/cm^3	104.5 watts/cm^3
Byron Unit 1 Cycle 11 through 18 Byron Unit 2 Cycle 10 through 17 Braidwood Unit 1 Cycle 9 through 17 Braidwood Unit 2 Cycle 9 through 16	<124 watts/cm^3	109.88 watts/cm^3
Byron Unit 1 Cycle 19 Byron Unit 2 Cycle 18 Braidwood Unit 1 Cycle 18 Braidwood Unit 2 Cycle 17	<124 watts/cm^3	111.67 watts/cm^3

With regard to the heat generation figure of merit, all reload fuel cycles except those specified below met the limit of less than or equal to 68 watts/cm^3.

Cycles that Exceeded the Figure of Merit

Cycle	Criteria	Figure of Merit (watts/cm^3)	Cycle Length
Byron Unit 1 Cycle 1	≤ 68 watts/cm^3	Corner 1 – 77.45 Corner 2 – 68.99	1.18 EFPY
Byron Unit 2 Cycle 1	≤ 68 watts/cm^3	Corner 1 – 76.85 Corner 2 – 68.30	1.19 EFPY
Braidwood Unit 1 Cycle 1	≤ 68 watts/cm^3	Corner 1 – 76.82 Corner 2 – 68.23	1.16 EFPY
Braidwood Unit 1 Cycle 3	≤ 68 watts/cm^3	Corner 1 – 70.14 Corner 2 – ≤ 68	1.13 EFPY
Braidwood Unit 2 Cycle 1	≤ 68 watts/cm^3	Corner 1 – 76.37 Corner 2 – ≤ 68	1.18 EFPY

Except for Braidwood Unit 1, the time the heat generation figure of merit exceeded the criteria was less than two (2) effective full power years (EFPY) and requires no further evaluation per the guidance provided in MRP 2013-025. As for Braidwood Unit 1, the total time the heat generation figure of merit exceeded 68 watts/cm^3 was 2.29 EFPY, which is slightly greater than the two (2) years stipulated in EPRI letter MRP 2013-025, Attachment 1. The relatively short duration, 0.29 EFPY, beyond the two (2) year limit is offset by the many years of operation where the heat generation figure of merit was below the limit.

Upper Axial Evaluation

Byron and Braidwood, Units 1 and 2, were evaluated as meeting upper axial boundary limitations specified in MRP 2013-025 of active fuel to upper core plate distance greater than 12.2 inches and average core power density less than 124 watts/cm^3. Byron and Braidwood, Units 1 and 2, have used standard 17x17 Westinghouse fuel product line fuel assemblies throughout the associated operating histories. Although documentation of active fuel to upper core plate distance could not be retrieved for all cycles, there is reasonable assurance that the criterion was met based on the use of standard fuel

product line fuel assemblies. The fuel assemblies are designed such that there is a gap between the upper fuel nozzle and the upper end of a fuel rod and a gap between the lower fuel nozzle and the lower end of the fuel rod. The active fuel to upper core plate distance is dependent on these gaps, since the gaps allow some variability in the relative distance from the active fuel to the upper core plate. Although cycle specific documentation of the gaps could not be located for each individual cycle, there is reasonable assurance that the distance criterion was met for all cycles. To simplify the manufacturing process, the distance between the bottom of lower fuel nozzle (lower core plate) and bottom of active fuel was standardized for all 17x17 fuel assemblies manufactured after May 1993. This standardization resulted in an active fuel to upper core plate distance of 13.22 inches. For cycles when fuel manufactured prior to May 1993 was used, the available documentation indicates that the active fuel to upper core plate distance ranged from 12.214 inches to 12.883 inches. Since standard fuel product lines were used prior to May 1993 in the cycles for which documentation is not available, a similar range in active fuel to upper core plate distance would have existed.

The only exception to the use of 17x17 Westinghouse standard fuel products was the use of eight (8) lead use assemblies (LUA) manufactured by another fuel vendor during Braidwood Unit 1, Cycles 15 and 16. These LUAs were installed in non-limiting core locations and the active fuel to core plate distance was greater than 12.2 inches.

The average core power density for all past Byron and Braidwood, Units 1 and 2, operating cycles was less than 124 watts/cm^3. A summary of the average core power densities is provided above.

<u>Lower Axial Boundary Evaluation</u>

Since the radial boundary criteria and upper axial boundary criteria were evaluated as being acceptable, the lower axial boundary criterion was met.

To ensure that these limits are met in future core designs, Byron and Braidwood Stations will continue to use low-leakage core loading in all future fuel cycles. The core design process will be modified to include a review for the following parameters:

- Active fuel – upper core plate distance >12.2 inches
- Average core power density <124 watts/cm^3
- Heat generation figure of merit $\leq$68 watts/cm^3