



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

January 12, 2017

LICENSEE: Exelon Generation Company, LLC

FACILITIES: Braidwood Station, Units 1 and 2, and Byron Station, Units 1 and 2

SUBJECT: SUMMARY OF DECEMBER 5, 2016, MEETING WITH EXELON GENERATION COMPANY LLC TO DISCUSS PROPOSED SUBMITTAL RELATED TO REACTOR PRESSURE VESSEL NOZZLE INSPECTIONS

On December 5, 2016, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a Category 1 public meeting with Exelon Generation Company, LLC (Exelon, the licensee) at NRC Headquarters, 11555 Rockville Pike, One White Flint North, Rockville, Maryland. The purpose of the meeting was to discuss Exelon's proposal to submit a request for relief from various inspection requirements and frequencies associated with the pressure vessel head penetration nozzles (RPVHPNs) as a result of ultra-high pressure (UHP) cavitation peening. Enclosure 1 contains a list of attendees. The licensee's presentation is available in the Agencywide Documents Access and Management System (ADAMS) under Accession No. ML16334A445.

**BACKGROUND:**

Pressurized-water reactor plants have experienced primary water stress corrosion cracking (PWSCC) in Alloy 82/182 dissimilar metal butt welds (DMWs), Alloy 600 reactor RPVHPNs, and associated Alloy 82/182 J-groove welds. Circumferential and axial cracks have been found in these components in several U.S. and international nuclear power plants, challenging the leak-tightness and structural integrity of the subject components. As a result of PWSCC, the NRC requires augmented inspections for these DMWs, RPVHPNs, and associated J-groove welds. For the unpeened nozzles and welds at issue, current regulatory requirements establish inspection periodicities and modalities (techniques) as required by Section 50.55a to Title 10 of the *Code of Federal Regulations* (10 CFR). These requirements are intended to ensure the probability of PWSCC crack growth to a through wall flaw size is sufficiently low to provide adequate assurance of structural integrity.

Byron and Braidwood units applied an UHP cavitation peening process, which uses submerged UHP water jets to treat the surfaces of reactor vessel components susceptible to PWSCC. The intent being rather than allowing random fractures to develop on a component's surface, this cavitation peening would create compressive stresses on the surface of the material in a controlled manner, which is intended to mitigate initiation of PWSCC.

The NRC staff has determined that the application of peening, as described in "Materials Reliability Program: Topical Report for Primary Water Stress Corrosion Cracking Mitigation by Surface Stress Improvement," Revision 3 (MRP-335R3, or the MRP) (ADAMS Accession No. ML166055A215), is not in conflict with any aspect of the American Society of Mechanical

Engineers (ASME) Code, Sections III and XI, or NRC regulations. The MRP uses a series of deterministic and probabilistic calculations to quantify the relationship among peening, inspection frequency and modality, and through wall cracking probability.

The NRC staff notes that relief from the ASME Code and NRC regulations is not required to perform peening on DMWs or RPVHPNs. The staff further notes that the peening application as described in MRP [materials reliability program]-335R3 is distinctly different than peening for the purpose of distortion control as described in the ASME Code, Section III. Each nuclear power plant may apply peening to components and evaluate its acceptability in accordance with the requirements of 10 CFR 50.59, "Changes, Tests, and Experiments." However, the ability of a licensee to self-evaluate the acceptability of peening plant components does not extend to the modification (i.e., relaxation) of current inspection requirements of peened components.

The MRP proposes to apply peening as a mitigation method to prevent PWSCC from occurring at DMWs in primary loop piping, RPVHPNs, and associated J-groove welds that are fabricated from nickel-based Alloy 600/82/182 material. As part of peening, the MRP proposes to relax the current inspection requirements for the peened DMWs and RPVHPNs. MRP-335R3 contains the technical basis for peening application, including affected components, peening processes, performance criteria, analyses, and alternative inspection requirements.

In a letter dated August 24, 2016 (ADAMS Accession No. ML16208A485), the NRC found that MRP-335R3 is acceptable for referencing in licensing applications for nuclear power plants to the extent specified and under the limitations delineated in the MRP and the approved final safety evaluation.

#### DISCUSSION:

A video was shown by the licensee to demonstrate the peening process used in support of PWSCC mitigation for the Byron/Braidwood facilities. The licensee indicated that future submittals will be provided requesting relief from performing the follow-up inspections currently required at the first and second refueling outage after peening, as well as the inspections in the next 10-year interval. The basis for this request was discussed. The expanded scope of the coverage area peened, combined with some conservative assumptions made have provided what the licensee has identified as extensive margins. The licensee cited the rigor or technical review and extent of the margins as support for relief from follow-up inspections.

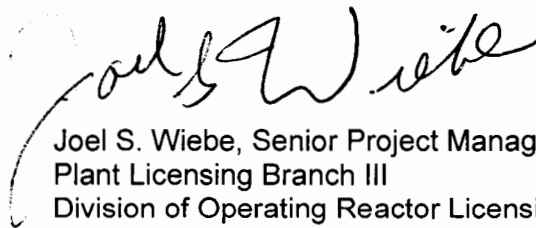
The licensee discussed the applicability of this request to Byron, Unit 2, as some nozzles could not be tested due to leakage. The licensee indicated the mitigation method, the pending mitigation activities, and the intended scope of the submittal. It was discussed that information on components would be needed to support that request. Additionally, the licensee addressed the use of a different x-ray diffraction methodology which was indicated to provide more accurate and repeatable results in support of required stress measurements. The NRC staff indicated that the licensee should provide a summary of the methodology, including controlling inputs and assumptions, as well as the results. The licensee identified where the verification and validation was performed. The NRC staff indicated an interest in the technique generally and suggested submittal of information by the associated industry group. For use in the proposed requests, the staff would be looking for a discussion on the process for reportability and repeatability.

The discussion included peening parameters margins, which focused on the extent of coverage, depth of compression, and post-peening stress accuracy. NRC comments included ensuring a discussion is included on thermal sleeves and centering tabs. The NRC staff indicated an interest in the licensee providing full drawings in support of the stress accuracy analysis and in seeing a discussion addressing whether thermal sleeves were included in the mock-up and whether weld residual stresses were impacted by the centering tabs.

Part of the deterministic justification for the proposed request for relief rests on the results of the crack growth analysis. An industry paper was discussed which the licensee has identified as additional support to the results of the deterministic crack growth analysis performed using an unapproved method (UAM). The licensee indicates that the industry paper provides sufficient conservatism to support the extension of the inspection interval even if credit for peening was not taken or approved. The NRC staff indicated concerns with the application of the UAM as there are concerns with defense in depth, the presumption of no crack initiation, and whether the analyses is appropriately bounding for the use proposed. Additionally, no applicable operating experience has been identified. The staff notes that the use of an UAM could significantly affect the review time for the request.

Overall, the NRC staff indicated that all margins being credited should be explicitly identified, along with any associated process or inspection uncertainties; and for any required coverage with small margins additional information should be provided. For the total margins, the staff indicated an interest in seeing the total margin represented as a percentage of the total area. The staff summarized that, in general, details should be provided regarding the peening process applied, testing of components, quality control of applicable processes, analyses, inspections, and testing, stress measurement uncertainties, essential variables and input values, as well as performance criteria. No commitments or regulatory decisions were made by the NRC staff during the meeting.

Sincerely,



Joel S. Wiebe, Senior Project Manager  
Plant Licensing Branch III  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-456, STN 50-457,  
STN 50-454 and STN 50-455

Enclosure:  
List of Attendees

cc w/encl: Ms. Ruth Thomas  
354 Woodland Drive  
Columbus, NC 28722

Distribution via Listserv

**Attendees**  
**U.S. Nuclear Regulatory Commission**  
**Public Meeting with Exelon**  
**Concerning PWSCC Mitigation Inspection Frequency**  
**December 5, 2016**

U. S. NUCLEAR REGULATORY COMMISSION

Ali Rezai  
Roger Kalikian  
Stephen Cumbridge  
John Tsao  
Jay Collins  
Margaret Audrain  
Eva Brown

EXELON GENERATION COMPANY LLC

Jessica Krejcie  
Bernie Rudell  
Ben Youman  
Brad Lanka  
Darren Gardner

Enclosure

SUMMARY OF DECEMBER 5, 2016, MEETING WITH EXELON GENERATION COMPANY LLC TO DISCUSS PROPOSED SUBMITTAL RELATED TO REACTOR PRESSURE VESSEL NOZZLE INSPECTIONS January 12, 2017

DISTRIBUTION:

PUBLIC	RidsNrrDeEpnb
LPLIII R/F	RidsNrrDss
LSPB R/F	RidsOgcRp
RidsNrrDorlLpIII	JCollins
RidsNrrDorlLspb	RKalikian
RidsNrrPMBByron	SCumblidge
RidsNrrPMBraidwood	MAudrain
RidsAcrcs_MailCTR	JTsao
RidsNrrDssSbpb	AREzai
RidsNrrLASRohrer	EDO
RidsRgn3MailCenter	

**ADAMS Accession No.: ML17009A067**

**NRC-001 \*via e-mail**

OFFICE	LPLIII/PM	LPLIII/PM	LPLIII/LA	LPLIII/BC
NAME	EBrown*	JWiebe	SRohrer	DWrona
DATE	12/19/13	1/11/17	1/10/17	1/12/17

**OFFICIAL RECORD COPY**