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U. S. Nuclear Regulatory Commission
ATTN: 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. 50-456 and 50-457

Subject: Additional Information Supporting Braidwood I3R-04, Request for Relief from 10 CFR 50.55a(g)(6)(ii)(E), Reactor Coolant Pressure Boundary Examination Scheduling Requirements in accordance with 10 CFR 50.55a(a)(3)(i)

References:

1. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. NRC, "Third 10-Year Inservice Inspection Interval, Relief Request I3R-04, Request for Relief from 10 CFR 50.55a(g)(6)(ii)(E), Reactor Coolant Pressure Boundary Examination Scheduling Requirements in accordance with 10 CFR 50.55a(a)(3)(i)," dated February 5, 2009

2. Letter from P. R. Simpson (Exelon Generation Company, LLC) to U. S. NRC, "Supplemental Information Regarding Relief Request I3R-04 Associated with the Third 10-Year Inservice Inspection (ISI) Interval," dated February 26, 2009

3. Letter from M. J. David (U. S. NRC) to C. G. Pardee (Exelon Generation Company, LLC) "Braidwood Station, Units 1 and 2 – Request for Additional Information Related to Relief Request I3R-04 (TAC Nos. ME0598 and ME0599)," dated March 5, 2009

In Reference 1, Exelon Generation Company, LLC (EGC), requested authorization to use augmented NDE examinations performed during previous refueling outages as an alternative to the reactor vessel bottom-mounted instrument (BMI) penetrations examination program required in accordance with 10 CFR 50.55a(g)(6)(ii)(E), Footnote 1. EGC supplemented that request with Reference 2.

The NRC requested additional information to support review of the relief request in Reference 3. The Attachment to this letter provides the requested information.

There are no regulatory commitments contained in this letter. If you have any questions concerning this letter, please contact Ms. Lisa A. Schofield at (630) 657-2815.

Respectfully,

Patrick R. Simpson
Manager – Licensing

Attachment: Relief Request I3R-04 Response to Request for Additional Information

Question 1

What are the critical flaw locations and orientations? How were these critical flaws incorporated in the demonstration?

Our understanding is that the mockups contained radial and circumferential flaws located on the wetted surface of the attachment weld. Our understanding from ultrasonic testing (UT) examination of control rod drive mechanism (CRDM) penetrations is that UT is unable to detect stress-corrosion cracking (SCC) in the J-groove welds unless the SCC is very close to the interface between the penetration and the weld. Since the report indicates that all flaws were detected, please explain how the defects located on the wetted surface of the attachment weld were detected in view of the experience with UT of CRDM penetrations.

Response

The critical flaw locations and orientations are above, below, and over the partial penetration weld in the circumferential orientation. As indicated in MRP-166, page A-4, Axial / radial and circumferential / radial flaws are located in the tube above, below, and/or over the attachment weld area (a circumferential flaw is defined as the weld-to-vessel intersection line). Radial and circumferential flaws are also located on the wetted surface of the attachment weld. The radial and circumferential flaws located on the surface of the wetted surface area of the weld were only designed to be used for detection with eddy current (ET), not UT.

The required CRDM inspection volume was from the bottom of the tube to 2" above the weld. There was no required inspection volume for the bottom-mounted instrument (BMI) penetrations, but in the Westinghouse 3- and 4-loop mockup, flaws were placed within 1" above and below the weld as the weld causes distortion in the tube and this would be the most challenging to examine in the field. The CRDM demonstrations were performed from below the dry mockup while the BMI demonstrations were performed from above the submerged mockup (similar to how they would be inspected in the field). All of the inside diameter (ID) and outside diameter (OD) connected flaws representing the flaws of interest for the BMI were detected in the Westinghouse 3- and 4-loop mockups. The ET J-groove equipment (J-groove Orbiter system) was not fully operational at the time and its use was not demonstrated. When MRP-166 mentioned that all flaws were detected, it was only referring to the tube flaws.

Question 2

For the Westinghouse 3- and 4-loop design:

a) Please characterize the flaw population distribution for the mockups (i.e., range of flaw length and depth, orientation, and types)?

b) What types of implants were used to generate flaws?

c) If cold isostatic processing (CIP) flaws were used in the mockups, please provide information on the degree of squeezing during the CIP process and whether the squeezed notches are representative of SCC. Please provide the radius of the CIP flaw tips or a direct comparison with flaws used by Performance Demonstration Initiative in Appendix VIII qualifications, and any reports that compare the response of the flaws used in the mockups with the responses from SCCs.

d) Did the mockups have any flaws that are representative of fabrication defects? Please provide information on how the UT examiners know the difference between indications from a service induced defect and a fabrication defect.

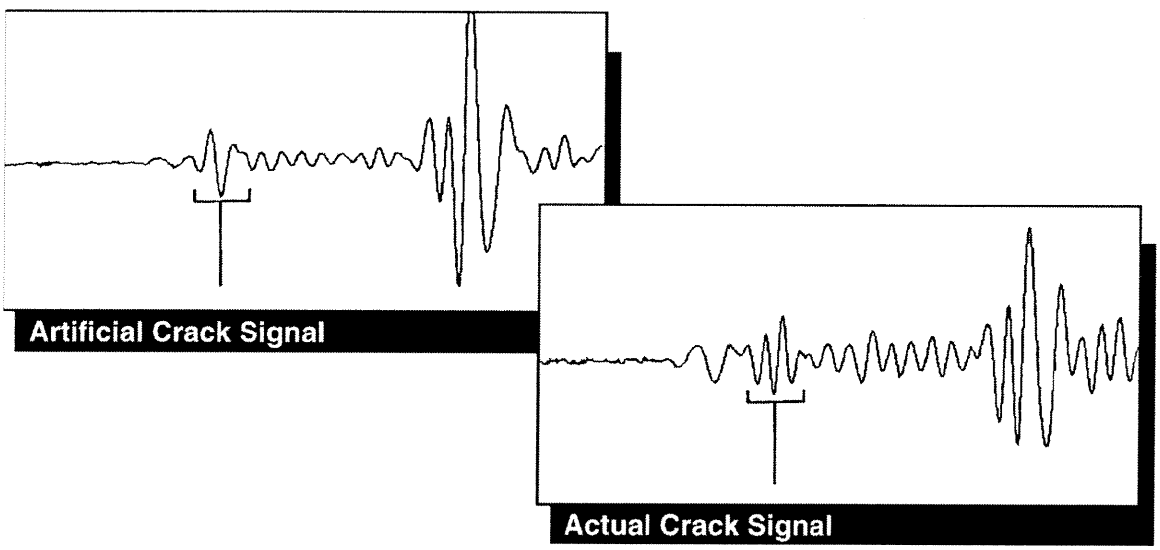
e) Do the mockups include a lack of fusion at the weld/tube interface?

Response

a. Most of these mockups are still considered blind so the flaw distributions cannot be provided in these responses. The mockups are full-scale with as-built weld geometries and have realistic distortion as caused by the J-groove weld. The flaws range in depth, length, and orientation. The mockups used for the capability study have more than 30 realistic flaws implanted in them, as documented in References 1 and 2.

b. The implants are cold isostatic press (CIP) squeezed EDM notches in the tube.

c. Typically the radius of the squeezed CIP notch tips used in CRDM and BMI flawed mockups are 10 microns, which is smaller than that required by ASME Section XI, Appendix VIII. Additionally, the ultrasonic notch responses have been compared to a primary water stress corrosion cracking (PWSCC) flaw at the Bugey plant, as shown in the figures below and documented in Reference 1.



d. Fabrication defects were not intentionally implanted in the mockups; however, some mockups contained several actual fabrication defects that were induced during the actual fabrication of the mockups. The vendors' ultrasonic procedures include instructions for evaluating fabrication defects. Service induced flaws are typically planar in nature whereas fabrication indications appear as volumetric responses. Flaws that are seen by circumferential and axial time-of-flight diffraction (TOFD) and the zero degree transducer are considered volumetric in nature and are noted as fabrication defect indications by procedure. Material shared with the vendors to assist them with their procedure improvements and differentiation between fabrication flaws and cracking is located in Chapter 6 of Reference 2.

e. Lack of fusion was not was intentionally implanted at the weld / tube interface.

Question 3

Please provide the criteria that will be used to determine recordable indications. For reporting criteria, how are service induced defects differentiated from fabrication indications, particularly if the mockups do not contain fabrication indications.

Response

The Paragon system was used for the Braidwood Unit 1 and Unit 2 examinations. Primary indication detection for Paragon system BMI inspections is performed using axial and circumferential TOFD ultrasonic techniques. Early in the analysis process, data analysts verify the presence of the lateral wave and that adequate data coverage and quality criteria are satisfied. Data is reviewed for areas of linear loss of backwall. If a loss of backwall is accompanied by a reduction in grain noise, there is potential for a flaw greater than 0.4" deep from the outside diameter to exist, but the tip signal may be obscured by the lateral wave. If a deep indication is suspected, eddy current data is reviewed for surface or near surface indications. Any areas where the lateral wave is lost are further investigated to determine if a tip signal or loss of backwall signal exist. The loss of the lateral wave accompanied by a loss of backwall signal can be indicative of a through wall defect. Data is reviewed for the presence of tip signals, which if confirmed, are investigated further. Additional zero degree longitudinal and 45-degree shear wave data is available to assist in detection and characterization of indications if required.

For ET data analysis, all indications must be evaluated and all relevant indications with a peak magnitude equal to or greater than the reference notch (0.040") peak magnitude must be reported. Flaw-like indications regardless of size are reported.

Additional guidance addressing fabrication defect evaluation was incorporated into the Paragon inspection procedures after the MRP-166 demonstrations. ET procedures discuss evaluating "false positive" indications, which include conditions such as signals from surface condition resulting from grinding on the outside diameter surface during initial fabrication, weld blending, etc.

Question 4

In general, is there any particular flaw type/orientation/size/location that may be missed? More specifically, time-of-flight diffraction (TOFD) UT has a known limitation for near surface inspection in that the presence of the lateral wave may obscure the detection of small flaws near the scan surface. Is this a concern for these inspections? Why/why not?

Response

The Westinghouse 3- and 4-loop Paragon demonstration missed no flaws from the ID or OD (paragraph 3.1.2.1 of MRP-166). The TOFD UT limitation is not a concern since the disruption of the lateral wave is an indication of an ID connected flaw that is generally seen. A supplemental ET examination was also performed. While a deep OD initiated flaw may not have a resolvable tip from the ID, TOFD can find this by looking for shadowing of the backwall / weld interface.

Question 5

MRP-166 notes that the vendor's procedure will identify responsibilities and qualification requirements for personnel carrying out several functions including documenting minimum personnel training requirements and qualifications for acquisition and analysis. In light of the fact that a high degree of operator skill is required to correctly interpret TOFD UT inspection results, please provide a summary of the training and qualification requirements for personnel who carried out the TOFD UT data acquisition and analysis?

Response

In accordance with WesDyne inspection procedures, all data acquisition (both UT and ET) is performed using Paragon computer operators under the direction / supervision of Level II or Level III qualified personnel. WesDyne and their contractor NDE personnel are qualified to a written practice that meets WesDyne's Procedure WDP-9.2, "Qualification and Certification of Personnel in Nondestructive Evaluation," which is based on the requirements of ASNT TC-1A, CP-189, and ASME Section XI, as applicable. Additional training for BMI specific inspection application is as follows:

- For BMI Data Acquisition – The requirement is for 80 hours of Paragon Operator Training for Reactor Vessel Exams. Included in this course is training on the Basic TOFD theory, BMI Acquisition Procedure Review, Paragon TOFD display setup, and acquisition responses from BMI tubes.

- For BMI Data Analysis – The Basic Paragon Operator Training is a prerequisite for BMI analysis. The requirement for a BMI analyst is a 40-hour BMI specific course. The course covers additional BMI Theory, TOFD Calibration, Data Quality, Acquisition and Analysis Procedure Reviews and Hands On with recent field inspection data.

In addition to the training above, two of the four Wesdyne individuals used for the Braidwood BMI inspections also participated in the Phase I and Phase II demonstration activities for the Paragon system, which are discussed in MRP-166. For the BMI inspections performed at

Braidwood Station, the final interpretation and evaluation of all acquired UT and ET data was limited to four certified individuals. These individuals were certified to either Level II or Level III UT and ET. In addition to holding valid UT and ET certifications, these individuals also held active Performance Demonstration Initiative (PDI) Appendix VII and VIII qualifications in either austenitic or dissimilar metal weld detection and length sizing inspection methods, demonstrating their ability and experience in ultrasonic inspection techniques and in discerning stress corrosion cracking indications. The individuals used at Braidwood had PDI UT experience hours ranging from 3,700 to over 16,000 hours and ET experience hours ranging from 1,600 to over 12,000 hours.

Question 6

MRP-166 is dated March 2006; however, most of the information it contains dates back to 2004. Please identify which of the three demonstrated systems in MRP-166 was used at Braidwood. Is the system as described in MRP-166 the same as used at Braidwood? If not, what has been done since 2004? Has this equipment been demonstrated on mockups?

Response

The Paragon system was used for the Braidwood Unit 1 and Unit 2 examinations; however, later revisions of the procedures discussed in MRP-166 Section 3.1.1 were used. The later revisions incorporated several improvements based on lessons learned after the original MRP-166 demonstrations were performed. Although not specifically discussed in MRP-166, the Paragon system also uses zero degree longitudinal wave and 45-degree shear wave scans which assist in the detection and evaluation process. Both the zero degree longitudinal wave and 45-degree shear wave transducers were modified to obtain a better signal to noise ratio and the size and frequency of each transducer was optimized. The zero degree transducer was improved by changing to a composite element.

The MRP-166 demonstration in early 2004 used both Paragon and IntraSpect systems. In the fall of 2004, the data was reanalyzed using the Paragon system with an analysis procedure that had been revised based on lessons learned from the initial demonstration and field applications of this procedure. The reanalysis reduced false calls and the Paragon system was considered acceptable for field use. These improvements to the Paragon system were demonstrated on mockups, but have not been demonstrated at the EPRI NDE Center as all the ID and OD connected flaws were detected in the 3- and 4-loop Westinghouse data with no false calls in the 2004 demonstrations discussed in MRP-166.

Question 7

The equipment from two vendors was evaluated in MRP-166. The regression analyses presented in MRP-166 seem to indicate that the Vendor A system significantly out-performed the Vendor B system for length and depth measurements for the Westinghouse 3- and 4-loop Design. Why is that? Would the Vendor B system at the time of the Braidwood inspections perform as well as the Vendor A system in MRP-166?

Response

The reason Vendor A seemed to out-perform Vendor B is unknown. It is not known if Vendor B can perform as well as Vendor A today. However, improvements in the Paragon system detection and sizing equipment and procedures based on the initial MRP-166 demonstrations were implemented during the Braidwood BMI inspections.

In 2007, the IntraSpect Analysis procedure was revised to incorporate improvements that had been learned through three years of field use with the Paragon system. The latest revisions of the IntraSpect Analysis procedure were recently demonstrated for use at the Koeberg site.

The improvements made to the IntraSpect system in 2007 were based on the improvements to the Paragon system in 2004, and the false calls to the IntraSpect system were reduced. The improvements made to the Paragon system in 2004 eliminated the false calls that were originally reported by the Paragon system. Since a new demonstration has not been completed since these improvements were implemented, it cannot be established whether one vendor can perform better than the other.

Question 8

What is the implication of the Vendor B system's significant undersizing of length and depth measurements as shown in the regression analyses in MRP-166?

Response

The implications are unknown. There were no cracks observed during the inspections at Braidwood Station, so the sizing of indications was not required.

Question 9

MRP-166 notes in Attachment 1 that it is possible that inspection vendors will be provided confidential information on the flaw characteristics of a limited set of flaws contained in the mockups in cases where vendor weaknesses were identified. Per this statement, confirm whether the examinations used to demonstrate this technique were conducted only on the blind mockups.

Response

Blind mockups were used and if weaknesses were identified in their procedure, guided practice was employed to improve their analysis to better characterize flaws similar to PDI's guided practice. Confidential flaw truth information was not provided and the demonstrations were blind.

Question 10

Per the introduction section of MRP-166, it is noted that both Vendor A and Vendor B are still developing eddy current (ET) equipment for inspecting the wetted surface of the attachment weld. Additionally, there is little information in MRP-166 reporting on the ET portion of the examination. Please clarify what criteria were used to qualify the ET examination technique. Please elaborate on the results, limitations, status, etc. of the ET examinations. Do the regression analyses include results obtained via ET examination?

Response

The wetted surface ET tool is still in the development stage and no new tooling has been demonstrated at EPRI, therefore elaboration on criteria is premature. For the ET examinations of the base material, Vendor A included an ET sensor in their UT probe when scanning from the ID of the tube. No specific limitations were noted during the demonstration. For the regression analysis, Vendor A used ET data from the base material in conjunction with the UT data in detection and length sizing of flaws located on the ID surface of the tube.

ET of the base material is primarily a tool for length sizing and orientation of ID indications. UT is for flaw characterization information and through wall sizing. All base metal ID detection and sizing is a result of the two complimentary examinations used in this demonstration.

Question 11

In Section 3.1 of MRP-166, the discussion of the Vendor B Demonstration, a statement is made that the J-groove ET exam had an issue with being unable to examine the entire area of interest. Has this been addressed? At the time of the Braidwood inspection what was the status of Vendor B's upgrade of their examination tool? Please address whether a new tool was successfully demonstrated.

Response

The wetted surface ET tool is still in the development stage and has not been demonstrated with MRP as of this date and was not used at Braidwood Station.

Question 12

MRP-166 includes demonstrations of several inspection systems applied to several plant configurations. Please clarify which demonstration in MRP-166 applies to Braidwood including specific information on: (1) the nominal ID of the appropriate mockup and how that compares to the nominal ID found at Braidwood, and (2) the examination equipment used for the demonstration that applies to Braidwood.

Response

The mockup used to demonstrate the WesDyne Paragon UT/ET system used at Braidwood Station was developed based on Westinghouse four loop dimensions and is depicted in MRP-166 Figure A-2 (Attachment 1, Page A-6). The nominal ID of the mockup is 0.600," which is identical to the nominal ID of the BMI tubes installed in both Braidwood Unit 1 and Unit 2 and thus the Braidwood inspection equipment and procedures are fully within the demonstration of the WesDyne Paragon system evaluated in MRP-166.

References

1. EPRI Technical Report TR-106260, "Demonstration of Inspection Technology for Alloy 600 CRDM Head Penetrations," October 1996

2. EPRI Project Summary 1015143, "Nondestructive Evaluation: Comparison of Field and Manufactured Flaw Data in Austenitic Materials," December 2007