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L-09-309

10 CFR 50.55a

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

SUBJECT:
Beaver Valley Power Station, Unit No. 2
Docket No. 50-412, License No. NPF-73
10 CFR 50.55a Request for Alternative Weld Repair Method for Reactor Vessel Head Penetration J-Groove Welds

In accordance with 10 CFR 50.55a, Nuclear Regulatory Commission (NRC) review and approval is requested for a proposed alternative to certain requirements associated with reactor vessel weld repairs for Beaver Valley Power Station Unit No. 2 (BVPS-2). The NRC staff previously approved an alternative repair method for Reactor Head Penetration and J-groove welds as described in BVPS-2 10 CFR 50.55a Request submitted on October 6, 2009 (Accession Number ML092700031).

FENOC is requesting that the NRC staff approve the proposed 10 CFR 50.55a request, which will allow a significant personnel dose savings by utilizing the surface examination acceptance criteria of the original construction code for the required surface examination of weld overlay repairs.

During the current BVPS-2 fourteenth refueling outage that began on October 12, 2009, the reactor vessel head penetrations and J-groove welds were inspected. Examination results for welds at reactor vessel head penetrations numbers 49 and 57 did not meet the applicable acceptance criteria and therefore these welds required repair. The repair methodology described in the previously approved 10 CFR 50.55a request requires the entire surface of the weld overlay repair to be examined by dye penetrant test (PT) with acceptance criteria of "PT White," no indications. A significant amount of personnel radiation exposure has been expended (approximately 54,000 mRem) while conducting the required reactor vessel head inspections and performing the repairs on reactor head penetration numbers 49 and 57. An additional 20,000 mRem is estimated to be expended in order to meet the acceptance criteria of "PT White," no indications, versus the applicable ASME Code acceptance criteria.

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The enclosed 10 CFR 50.55a request is based on the original request submitted by FENOC letter dated October 9, 2008 as supplemented by FENOC letter dated May 19, 2009. The applicable aspects of these two letters are incorporated in the proposed 10 CFR 50.55a request. The main technical difference between the previously submitted request and the request enclosed in this letter is the acceptance criteria previously discussed. Consistent with WCAP-15987 methodology, Alloy 52 material was added as a weld overlay material that may be used.

The affected components, the applicable ASME Code requirements, a description of the proposed alternative and bases for the proposed alternative is provided in the enclosure to this letter. The alternative is proposed for use during the remainder of the current BVPS-2 10 year ISI interval, which ends August 28, 2018.

The proposed alternative is to be implemented during the ongoing maintenance and refueling outage. Therefore, FENOC is requesting expedited review and approval of the proposed alternative.

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Thomas A. Lentz, Manager – Fleet Licensing, at 330-761-6071.

Sincerely,

Paul A. Harden

Enclosure:
10 CFR 50.55a Request No. 2-TYP-3-RV-03

cc: NRC Region I Administrator
NRC Senior Resident Inspector
NRC Project Manager
Director BRP/DEP
Site BRP/DEP Representative

Proposed Alternative in Accordance With 10 CFR 50.55a(a)(3)(i)

1.0 ASME CODE COMPONENTS AFFECTED

Component Numbers:	2RCS-REV-21 (Reactor Vessel) Reactor Vessel Head Penetrations 1 through 65
Code Class:	Class 1
Examination Category:	B-P
Item Number:	B15.10
Description:	Alternative Repair Methods for Reactor Vessel Head Penetrations and J-Groove Welds

2.0 APPLICABLE CODE EDITION AND ADDENDA

Beaver Valley Power Station Unit No. 2 (BVPS-2) In-Service Inspection and Repair/Replacement Programs:	American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, 2001 Edition through 2003 Addenda
BVPS-2 Code of Construction (Reactor Vessel):	ASME Code Section III, 1971Edition through Summer 1972 Addenda

3.0 APPLICABLE CODE REQUIREMENTS

IWA-4000 of ASME Section XI contains requirements for the removal of defects from and welded repairs performed on ASME components. The specific Code requirements for which use of the proposed alternative is being requested are as follows:

ASME Section XI, IWA-4421 states, that:

Defects shall be removed or mitigated in accordance with the following requirements:

(a) Defect removal by mechanical processing shall be in accordance with IWA-4462.

(b) Defect removal by thermal methods shall be in accordance with IWA-4461.

(c) Defect removal or mitigation by welding or brazing shall be in accordance with IWA-4411.

(d) Defect removal or mitigation by modification shall be in accordance with IWA-4340.

Note that use of the "Mitigation of Defects by Modification" provisions of IWA-4340 is prohibited per 10 CFR 50.55a(b)(2)(xxv).

For the removal or mitigation of defects by welding, ASME Section XI, IWA-4411 states, in part, the following.

> *Welding, brazing, and installation shall be performed in accordance with the Owner's Requirements and . . . in accordance with the Construction Code of the item . . .*

The applicable requirements of the Construction Code required by IWA-4411 for the removal or mitigation of defects by welding from which relief is requested are as follows.

For defects in base material, ASME Section III, NB-4131 requires that the defects are removed, repaired, and examined in accordance with the requirements of NB-2500. These requirements include the removal of defects via grinding or machining per NB-2538 and, if necessary to satisfy the design thickness requirement of NB-3000, repair welding in accordance with NB-2539.

Similarly, with respect to defects in weld material, ASME Section III, NB-4451 requires that unacceptable defects in weld metal be eliminated and, when necessary, repaired in accordance with NB-4452 and NB-4453.

4.0 REASON FOR REQUEST

Prior to the fall 2009 refueling outage (2R14), reactor vessel head penetration repairs have been performed on four penetrations in the BVPS-2 reactor head. Three repairs were implemented during the 2R12 (Fall 2006) Refueling Outage, with an additional repair being required during the 2R13 (Spring 2008) Refueling Outage. All of these repairs were implemented in accordance with Beaver Valley Power Station Relief Request BV3-RV-04 (References 1, 2, and 3), which was approved by the NRC (Reference 4) for the BVPS-2 Second 10-year ISI interval, which expired on August 28, 2008. This 10 CFR 50.55a request (relief request) is being submitted for the Third 10-year ISI interval for a variety of postulated repair scenarios using the embedded flaw repair approach, supported by a combination of generic and plant-specific technical bases. This relief request is needed to complete the repair initiated during the current 2R14 refueling outage.

During the BVPS-2 Third 10-year ISI interval, which began August 29, 2008, FirstEnergy Nuclear Operating Company (FENOC) will be performing examinations of the reactor vessel head in accordance with Code Case N-729-1 with conditions as specified in 10 CFR 50.55a(g)(6)(ii)(D). To address any need to repair unacceptable indications in reactor head penetrations or J-groove welds at BVPS-2, relief is requested from the requirements of ASME Code Section XI, IWA-4421, IWA-4411, and the applicable sections of the Construction Code. Specifically, relief is requested from the requirements of ASME Code Section III, NB-4131, NB-2538, and NB-2539 for the removal of base material defects prior to repair by welding and from NB-4451, NB-4452, and NB-4453 for the removal of weld material defects prior to repair by welding.

5.0 PROPOSED ALTERNATIVE AND BASIS FOR USE

The NRC Safety Evaluation for WCAP-15987 (Reference 6) specified the use of "Flaw Evaluation Guidelines," sent to the Nuclear Energy Institute (NEI) by letter dated April 11, 2003 (Reference 9). In lieu of these guidelines, FENOC proposes to follow the criteria for flaw evaluation established in 10 CFR 50.55a(g)(6)(ii)(D), which specifies the use of Code Case N-729-1 with conditions.

As an alternative to the defect removal requirements of ASME Section XI and Section III, FENOC proposes the use of the embedded flaw repair process described in WCAP-15987, Revision 2-A (Reference 5) for the repair of unacceptable indications in reactor vessel head penetrations and J-groove welds, as approved by the NRC in correspondence to the Westinghouse Electric Company dated July 3, 2003 (Reference 6). Design, implementation of the repairs, and inspections will be consistent with WCAP-15987, WCAP-16158-P, and ASME Code Case N-729-1. Pursuant to 10 CFR 50.55a(a)(3)(i), the alternative is proposed on the basis that it will provide an acceptable level of quality and safety while conserving radiological dose.

5.1 Inside Diameter (ID) Repair Methodology

Consistent with WCAP-15987 methodology, the following repair requirements are proposed for an inside diameter (ID) repair.

An unacceptable axial flaw will be first excavated (or partially excavated) to a depth no greater than 0.125 inches. Although this depth differs from that specified in WCAP-15987, Revision 2-A, Section 2.2.1, the cavity depth is not a critical parameter in the implementation of a repair on the ID surface. The goal of the inlay is to isolate the susceptible material from the environment. The purpose of the excavation is to accommodate the application of weld layers to meet that requirement. The depth specified in WCAP-15987 (Reference 5) is a nominal dimension and the depth needed to accommodate three weld layers while still maintaining the tube ID. Since two weld layers will be applied, less excavation is required and 0.125 inches of excavation is all that is needed. The smaller thickness of the cavity excavated for two layers would mean a slightly thinner weld, which would produce less residual stress.

The excavation will be performed using an Electronic Discharge Machining (EDM) process to minimize penetration tube distortion. After the excavation is complete, either an ultrasonic test (UT) or eddy current test (ECT) will be performed to ensure the entire flaw length is captured. Then a minimum of two layers of Alloy 52 or 52M weld material will be applied to fill the excavation. The expected chemistry of the weld surface is that typical of Alloy 52 weldment with no significant dilution. Finally, the finished weld will be machined to restore the inside diameter and then examined by dye penetrant test (PT), UT or ECT to ensure acceptability.

If an unacceptable ID circumferential flaw is detected, the flaw will either be repaired in accordance with existing code requirements, or will be partially excavated to reduce the flaw to an acceptable size, examined by UT or ECT, overlaid with Alloy 52 or 52M, and examined by PT, UT or ECT as described above.

5.2 Outside Diameter (OD) and J-groove Weld Repair Methodology

Consistent with WCAP-15987 methodology, the following repair requirements are proposed for outside diameter (OD) and J-groove weld repairs.

1. An unacceptable axial or circumferential flaw in a tube below a J-groove attachment weld will be sealed off with Alloy 52 or 52M weldment. Excavation or partial excavation of such flaws will not be required, since clearance is not a concern on the outside of a tube. The embedded flaw repair technique may be applied to OD axial or circumferential cracks below the J-groove weld because they are located away from the pressure boundary, and the proposed repair of sealing the crack with Alloy 690 weld material would isolate the crack from the environment as stated in Section 3.6.1 of the NRC staff safety evaluation for WCAP-15987.

2. Unacceptable radial flaws in the J-groove attachment weld will be sealed off with a 360 degree overlay of Alloy 52 or 52M covering the entire weld. No excavation will be required. The overlay will extend onto and encompass the outside diameter of the penetration tube. The seal weld will extend beyond the Alloy 600 weld material by at least one half inch as stated in the NRC safety evaluation for WCAP-15987.

3. Unacceptable axial tube flaws extending into the J-groove attachment weld will be sealed with Alloy 52 or 52M as in Item 1 above. In addition, the entire J-groove attachment weld will be overlaid with Alloy 52 or 52M to embed the axial crack in the seal weld on the penetration. The overlay will extend onto and encompass the outside diameter of the penetration tube. The seal weld will extend beyond the Alloy 600 weld material by at least one half inch as stated in the NRC safety evaluation for WCAP-15987.

4. For weld overlays performed on the J-groove attachment weld, the interface boundary between the J-groove weld and stainless steel cladding will be located with a hand held ferrite meter instrument that identifies this interface boundary. This technique has been successfully used at BVPS-2 for the positive identification of the weld clad interface to ensure that all of the Alloy 82 material of the J-groove weld is overlaid during the repair. Markings are made to locate the interface as well as a boundary of at least one half inch outboard of the stainless steel clad 182 interface.

5. For all of the above flaw configurations, the finished repair will be examined by PT, UT and ECT to ensure acceptability. Specifically, the entire surface of the overlay will be examined by PT. Additionally, the penetration tube will be examined from the ID surface

using UT and ECT to confirm that the repair process did not introduce any new flaws or adversely change the size or characteristics of the previously identified flaw(s). These examinations will be performed in accordance with ASME Code Case N-729-1 with conditions as specified in 10 CFR 50.55a(g)(6)(ii)(D).

6. The embedded flaw repair weld will be three layers thick for applications to the J-groove attachment welds, and at least two layers thick for application to base metal locations.

7. For all embedded flaw repairs, examinations of the overlay and original penetration during subsequent outages will be performed in accordance with the requirements of Code Case N-729-1 with conditions as specified in 10 CFR 50.55a(g)(6)(ii)(D).

8. No attempt will be made to embed an outside diameter circumferential flaw above the J-groove weld. Whenever an embedded flaw repair is planned for a circumferential flaw or a J-groove weld repair, the NRC will be notified.

5.3 Technical Basis for Proposed Alternative

As discussed in WCAP-15987, Revision 2-A, the embedded flaw repair technique is considered a permanent repair for a number of reasons. As long as a Primary Water Stress Corrosion Cracking (PWSCC) flaw remains isolated from the primary water (PW) environment, it cannot propagate. Since Alloy 52 weldment is considered highly resistant to PWSCC, a new PWSCC flaw cannot initiate and grow through the Alloy 52 overlay to reconnect the PW environment with the embedded flaw. Structural integrity of the affected J-groove attachment weld will be maintained by the remaining unflawed portion of the weld. Alloy 690 and Alloy 52 are highly resistant to stress corrosion cracking, as demonstrated by multiple laboratory tests, as well as over ten years of service experience in replacement steam generators.

The residual stresses produced by the embedded flaw technique have been measured and found to be relatively low, indicating that no new flaws will initiate and grow in the area adjacent to the repair weld. As described in WCAP-13998 (Reference 10), Section 7, the hole drilling method of residual stress measurement was used to determine the buildup of residual stresses from welding on the reactor vessel closure head and penetration tube. This technique involves mounting a three strain gage rosette at the location where the measurement is required. A small hole is drilled at the center of the rosette and the relieved strain is measured by the three gages of the rosette. The relieved strain and elastic constants of the material and the constants for the rosette are used to calculate the residual stress. There are no other known mechanisms for significant flaw propagation in this region since cyclic fatigue loading is negligible. Therefore, fatigue driven crack growth is not a mechanism for further crack growth after the embedded flaw repair process is implemented.

The thermal expansion properties of Alloy 52 weld metal are not specified in the ASME Code, as is the case for other weld metals. In this case, the properties of the equivalent base metal (Alloy 690) should be used. For that material, the thermal expansion coefficient at 600 degrees F is 8.2 E-6 in/in/degree F as found in Section II part D of the Code. The Alloy 600 base metal has a coefficient of thermal expansion of 7.8 E-6 in/in/degree F, a difference of about 5 percent.

The effect of this small difference in thermal expansion is that the weld metal will contract more than the base metal when it cools, thus producing a compressive stress on the Alloy 600 tube or attachment weld. This beneficial effect has already been accounted for in the residual stress measurements reported in the technical basis for the embedded flaw repair, as noted in WCAP-15987.

The small residual stresses produced by the embedded flaw weld will act constantly, and, therefore, will have no impact on the fatigue effects in this region. Since the stress would be additive to the maximum and minimum stress, the stress range will not change, and the already negligible usage factor for the region will not change.

WCAP-16158-P (Reference 7) provides the plant-specific analysis performed for BVPS-2 using the same methodology as WCAP-15987. This analysis provides the means to evaluate a broad range of postulated repair scenarios to the reactor vessel head penetrations and J-groove welds relative to ASME Code requirements for allowable size and service life.

Additionally, the post-repair examinations, consisting of ultrasonic, eddy current and dye penetrant testing, depending on the specific repair configuration, will be performed in accordance with ASME Code Case N-729-1 with conditions as required by 10 CFR 50.55a(g)(6)(ii)(D) prior to return to service.

Future inspections of reactor vessel head penetrations and J-groove welds repaired utilizing the embedded Flaw repair process, along with submission of any necessary reports, will be in accordance with 10 CFR 50.55a(g)(6)(ii)(D), which requires implementation of Code Case N-729-1 with certain conditions.

The above proposed alternative, as supported by the referenced generic and plant specific technical bases, is considered to be an alternative to Code requirements that provides an acceptable level of quality and safety.

6.0 DURATION OF 'THE PROPOSED ALTERNATIVE

The duration of the proposed alternative is for the remainder of the BVPS-2 Third 10-year Inservice Inspection Interval, scheduled to end in 2018.

7.0 PRECEDENT

In Reference 6, the NRC generically approved the embedded flaw repair process described in Reference 5. Requests to use the embedded flaw repair process to repair flaws in reactor vessel head penetrations and J-groove welds have been previously approved for Beaver Valley Power Station Unit Nos. 1 and 2 (References 1, 2, 3, and 4) and other pressurized water reactors on a plant-specific basis. There is no difference between the flaw repair process previously approved for Beaver Valley Power Station Unit Nos. 1 and 2 and the flaw repair process described in this request except for the post repair surface examination acceptance criteria, and the use of Alloy 52 weld material.

8.0 REFERENCES

1. FENOC Letter L-03-056, "Proposed Alternative Repair Methods for Reactor Vessel Head Penetrations (Relief Request No. BV3-RV-04)," March 28, 2003.
2. FENOC Letter L-03-064, "Supplemental Information Supporting Proposed Alternative Repair Methods for Reactor Vessel Head Penetrations (Relief Request No. BV3-RV-04)," April 4, 2003.
3. FENOC Letter L-03-065, "Revision 1 to Reply for Request for Additional Information Regarding Proposed Alternative Repair Methods for Reactor Vessel Head Penetrations (Relief Request No. BV3-RV-04)," April 7, 2003.
4. Beaver Valley Power Station, Units 1 and 2 - Evaluation of Inservice Inspection (ISI) Relief Request BV3-RV-04 (TAC Nos. MB8172 and MB8173), May 14, 2003.
5. Westinghouse WCAP-15987, Revision 2-A, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," December 2003.
6. Letter from H. N. Berkow (U. S. NRC) to H. A. Sepp (Westinghouse Electric Company), "Acceptance for Referencing - Topical Report WCAP-15987-P, Revision 2, 'Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations,' (TAC NO. MB8997)," dated July 3, 2003.
7. Westing house WCAP-16158-P, Revision 0, "Technical Basis for Repair Options for Reactor Vessel Head Penetration Nozzles and Attachment Welds: Beaver Valley Unit 2", November 2003.
8. Letter LTR-NRG-03-61 from J. S. Galembush (Westinghouse Electric Company) to Terence Chan (U. S. NRC) and Bryan Benney (U.S. NRC), "Inspection of Embedded Flaw Repair of a J-groove Weld," dated October 1, 2003.
9. Letter from R. J. Barrett (U. S. NRC) to A. Marion (Nuclear Energy Institute), "Flaw Evaluation Guidelines," dated April 11, 2003.
10. WCAP-13998, Revision 1, "RV Closure Head Penetration Tube ID Weld Overlay Repair," November 1995.