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

July 28, 2022

MILLSTONE POWER STATION, UNIT NO. 3 – AUTHORIZATION AND SAFETY EVALUATION FOR ALTERNATIVE REQUEST NO. IR-4-09 (EPID L-2021-LLR-0087)

LICENSEE INFORMATION

Recipient's Name and Address: Mr. Daniel G. Stoddard
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Licensee: Dominion Energy Nuclear Connecticut, Inc.

Plant Name and Unit: Millstone Power Station, Unit No. 3

Docket No.: 50-423

APPLICATION INFORMATION

Application Date: November 17, 2021

Application Agencywide Documents Access and Management System (ADAMS) Accession No.: ML21321A278

Supplement Date: N/A

Applicable Inservice Inspection (ISI) Program Interval and Interval Start/End Dates: The fourth inspection interval for Millstone Power Station, Unit 3 (MPS3) began on February 23, 2019, and is scheduled to end February 22, 2029.

Alternative Provision: The applicant requested an alternative under Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 50.55a(z)(2).

ASME Code Requirements: American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI "Rules for Inservice Inspection of Nuclear Power Plant Components," Articles IWD-3000 and IWA-4000.

Applicable Code Edition and Addenda: 2013 Edition of the American Society of Mechanical Engineers (ASME) Code, Section XI.

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Brief Description of the Proposed Alternative:

The licensee is proposing to permit the continued operation of leaking brazed joints between copper-nickel and nickel-copper Class 3 service water piping and bronze fittings. The proposed alternative is in lieu of immediate repair/replacement required by ASME Code, Section XI, Paragraph IWD-3132.2.

In lieu of repair, an ultrasonic examination (UT) is performed on leaking joints to determine percent bond between the pipe and fitting. For those brazed joints with at least 60 percent bond, no additional evaluation is required. This method is similar to the approach in ASME Code Case N-874, "Temporary Acceptance of Leakage Through Brazed Joints of Class 3 Copper, Copper-Nickel, and Nickel-Copper Moderate Energy Piping Section XI, Division 1." For leaking brazed joints with less than 60 percent bond, the UT results are compared with pre-established brazed joint bond levels required for structural integrity of the specific piping under consideration that accounts for the design basis loadings applicable to the degraded condition of the brazed joint being evaluated. This process is used to establish the basis for determining the joint integrity to the extent required for system operability.

Any brazed joint leakage that is detected and temporarily accepted using the proposed alternative evaluation criteria would be subject to ongoing monitoring, which includes periodic UT, and would be repaired in accordance with ASME Code, Section XI, Article IWA-4000 no later than the next refueling outage. When leaking is observed in a brazed joint, augmented examinations will be conducted on five similar brazed joints which are selected based on consideration of adjacency, train, fitting type, or other factors that may be evident from the specific condition. The alternative is limited to piping with a nominal size of three inches with a maximum operating pressure at no more than 150 pounds per square inch (psi).

The need to shut down the plant to implement an ASME Code repair of a brazed joint with minor leakage would result in hardship without a compensating increase in the level of quality and safety when the structural integrity of the degraded joint and associated system functionality can be ensured by appropriate evaluation.

For additional details on the licensee's submittal, please refer to the documents located at the ADAMS accession number identified above.

STAFF EVALUATION

On February 28, 2007 (ML070580514), the NRC approved a similar Relief Request, IR-2-38, for the second 10-year ISI interval for MPS3. Under Relief Request IR-2-38, three degraded brazed joints were evaluated without catastrophic failure prior to repair.

On November 30, 2009 (ML093221042), the NRC approved a similar Relief Request, IR-3-04, for the third 10-year ISI interval for MPS3. During the third MPS3 ISI interval, there were no degraded brazed joints requiring the use of the methodology approved in Relief Request IR-3-04.

The licensee stated that its proposed alternative, RR IR-4-09, is similar to the approach in ASME Code Case N-874 with the addition of a structural integrity assessment approach utilizing ASME Code Case N-513-4, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division," as guidance. At the time of the licensee's submittal of RR IR-4-09, Code Case N-874 was not endorsed by the NRC in Regulatory Guide (RG) 1.147, Revision 19, "Inservice Inspection Code Case Acceptability,

ASME Section XI, Division 1." Code Case N-513-4 was endorsed for use in RG 1.147, Revision 19. The NRC staff notes that Code Case N-513-4 is similar, in part, to ASME Code, Section XI, Nonmandatory appendix U, Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Piping and Class 2 or 3 Vessels, for the assessment of leaking class 2 and 3 moderate energy piping; however, neither the code case nor appendix U specifically addresses leaking brazed joints. Subsequent to the licensee's submittal, Code Case N-874 was endorsed for use by the NRC in RG 1.147, Revision 20.

Background Information on Leaking Silver Brazed Joints

In manual silver brazed piping joints, 100 percent bond between the pipe and the fitting is not possible to obtain. Even under the best circumstances, diametrical clearance varies between the pipe and the fitting around the joint circumference. These variations in diametrical clearance, along with surface oxides, improper brazing techniques and overheated flux, can prevent the brazing filler metal from wetting the pipe and fitting surfaces. The areas that are not bonded may be filled, in part, with dried flux that is very hard.

Many of these non-bonded areas can be connected from the bottom of the fitting, via a tortuous path, to the top of the fitting. Over time, this tortuous path of non-bonded area can allow water to finally reach the top of the joint causing a leak. Typically, the leakage rate is very low, a few drops per minute. In some cases, a leak is difficult to distinguish between a leak and condensation on the pipe. Issues with percent bond in silver brazed weld joints was first identified by the U.S. Navy in critical shipboard piping over 60 years ago. During destructive testing it was found that in some cases a silver brazed joint with only 10 percent bond, having a proper geometrical bond distribution, performed better than the pipe on which the brazed joint had been made.

To account for errors in ultrasonic testing and maldistribution of the bond around the circumference of the brazed joint, the U.S. Navy set a minimum 40 percent bond as acceptable. This number was subsequently raised to 60 percent to add additional margin (Hearings Before the Joint Committee on Atomic Energy Congress of the United States, Eighty-Eighth Congress, First and Second Session On, The Loss of the USS Thresher, June 26, 27, July 23, 1963, and July 1, 1964). The NRC staff is not aware of the specifics of the testing conducted by the U.S. Navy, such as pipe diameter, pipe thickness or fitting dimensions; however, the testing conducted shows that silver brazed joints are very robust and a fraction of 100 percent bond can provide sufficient structural integrity. It should be noted that the U.S. Navy acceptance by percent bond of production brazed joints also requires a visual examination and successful completion of a hydrostatic test. U.S. Navy brazer performance qualification requires a minimum of a 70 percent bond of the lapped area to successfully qualify a brazer (S9074-AQ-GIB-010/248, NAVSEA Technical Publication, Requirements for Welding and Brazing Procedure and Performance Qualification, August 1995). Silver brazed joints in U.S. Navy shipboard applications routinely operate at considerably higher operating pressures than the MPS3 service water piping.

Proposed Alternative Evaluation

The Construction Code for the MPS3 service water piping is ASME Code Section III, "Rules for Construction of Nuclear Power Plants," 1971 Edition with Summer 1973 Addenda. Original construction MPS3 brazed joints required a visual examination and hydrostatic test.

The major difference between the licensee's proposed alternative and Code Case N-874 is that the licensee's proposed alternative also permits continued operation of leaking brazed joints with less than 60 percent bond, based on an evaluation of structural integrity consistent with aspects of ASME Code and Code Case N-513-4.

The licensee proposes, in part, that for leaking brazed joints with 60 percent or greater bond, no further action is required except monitoring and repair/replacement by the end of the next refueling outage following discovery of the leakage. The NRC reviewed the portion of the licensee's proposed alternative for leaking brazed joints with 60 percent or greater bond and finds it acceptable because it is consistent with Code Case N-874 which has been endorsed in RG 1.147, Revision 20 as acceptable for use without conditions.

For brazed joints with less than 60 percent bond, the licensee's proposed alternative is consistent with Code Case N-874 with the exception that brazed joints with less than 60 percent bond may be permitted to stay in service after a structural elevation is performed.

The staff reviewed the methodology used by the licensee to assess structural integrity of brazed joints with less than 60 percent bond. The approach used in the licensee's assessment methodology and technical evaluation is consistent with aspects of the ASME Code and appropriately considers pressure loads, seismic loads, dead weight, and dynamic loads. In addition, the safety factor used as part of the methodology is consistent with Code Case N-513-4 and ASME Code, Section XI, Appendix C. The licensee validated its methodology by performing physical testing of several simulated bond configurations as well as several silver brazed joints from MPS3 piping. Daily visual observation of leaking brazed joints along with re-examination by UT at three-month intervals, as specified in the proposed alternative, will ensure that the percent bond used in the evaluation remains valid.

Based on the methodology used by the licensee as discussed above, the NRC staff finds that the licensee has provided reasonable assurance of structural integrity of brazed joints with less than 60 percent bond, and is, therefore acceptable.

A plant shutdown to repair a leaking brazed joint would unnecessarily cycle plant components, which is not desirable in maintaining the structural integrity of the safety-related components. The NRC staff finds that the need to shut down the plant for implementing an ASME Code repair of degraded brazed joints would result in hardship to the licensee without a compensating increase in the level of quality and safety when the structural integrity of the joint and the system functionality can be ensured by appropriate evaluation.

CONCLUSION

The NRC staff has determined that complying with the specified requirements described in the licensee's request referenced above would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The proposed alternative provides reasonable assurance of structural integrity of the subject component(s). The NRC staff concludes that the licensee has adequately addressed the regulatory requirements set forth in 10 CFR 50.55a(z)(2).

The NRC staff authorizes the use of proposed alternative IR-4-09, at MPS3, for the remainder of the MPS3 fourth 10-year Inservice Inspection Interval which is scheduled to end on February 22, 2029.

All other ASME BPV Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Robert Davis

Date: July 28, 2022

Hipolito J. Gonzalez

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Hipólito J. González, Chief
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SUBJECT: MILLSTONE POWER STATION, UNIT NO. 3 - AUTHORIZATION AND SAFETY EVALUATION FOR ALTERNATIVE REQUEST NO. IR-4-09 (EPID L-2021-LLR-0087) DATED JULY 28, 2022

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