October 28, 2003

Mr. David A. Christian
Sr. Vice President and Chief Nuclear Officer
Dominion Nuclear Connecticut, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: SAFETY EVALUATION OF RELIEF REQUEST RR-89-43, TEMPORARY INSTALLATION OF MECHANICAL NOZZLE SEAL ASSEMBLIES ON PRESSURIZER HEATER PENETRATION NOZZLES, MILLSTONE POWER STATION, UNIT NO. 2 (TAC NO. MC0279)

Dear Mr. Christian:

By letter dated August 11, 2003, Dominion Nuclear Connecticut, Inc. (DNC) submitted Relief Request RR-89-43 for Millstone Power Station, Unit No. 2 (MP2). Your submittal requested approval for the temporary use of Mechanical Nozzle Seal Assemblies (MNSAs) in the repair of degraded pressurizer heater penetration nozzles as an alternative to certain requirements of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). As discussed in your letter dated August 11, 2003, the use of the MNSAs was proposed as a temporary repair for a time period not to exceed two operating cycles.

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of the subject relief request. The staff's Safety Evaluation (SE) is enclosed. Our SE concludes that the proposed alternative to the ASME Code requirements described in Relief Request RR-89-43 will provide an acceptable level of quality and safety for repair of pressurizer heater penetration nozzles at MP2 for a time period not to exceed two operating cycles. Therefore, the alternative is authorized pursuant to Section 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations*. Since DNC's request was proposed as a contingency in the event any degraded pressurizer heater penetration nozzles are found in future outages, the staff authorizes the proposed alternative for installation of MNSAs, on an as-needed basis, for the time period commencing with the fall 2003 refueling outage (i.e., RFO 15) through the completion of RFO 16. In all cases, each MNSA is authorized as a temporary repair for a period not to exceed two cycles from the initial installation date.

The NRC staff considers that the non-timely submittal of your request (August 11, 2003, with a licensee need date of October 31, 2003) created an unacceptable short staff review time and did not contribute toward the NRC's goal of efficient and effective use of staff resources. I have discussed this issue with Mr. David Dodson of your staff.

Sincerely,

/RA/

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-336

Enclosure: Safety Evaluation

cc w/encl: See next page

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cc:

Lillian M. Cuoco, Esquire
Senior Counsel
Dominion Resources Services, Inc.
Rope Ferry Road
Waterford, CT 06385

Edward L. Wilds, Jr., Ph.D.
Director, Division of Radiation
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406

First Selectmen
Town of Waterford
15 Rope Ferry Road
Waterford, CT 06385

Charles Brinkman, Director
Washington Operations Nuclear Services
Westinghouse Electric Company
12300 Twinbrook Pkwy, Suite 330
Rockville, MD 20852

Senior Resident Inspector
Millstone Power Station
c/o U.S. Nuclear Regulatory Commission
P.O. Box 513
Niantic, CT 06357

Mr. W. R. Matthews
Senior Vice President - Nuclear Operations
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. P. J. Parulis
Manager - Nuclear Oversight
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. J. Alan Price
Site Vice President
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. John Markowicz
Co-Chair
Nuclear Energy Advisory Council
9 Susan Terrace
Waterford, CT 06385

Mr. Evan W. Woollacott
Co-Chair
Nuclear Energy Advisory Council
128 Terry's Plain Road
Simsbury, CT 06070

Ms. Nancy Burton
147 Cross Highway
Redding Ridge, CT 00870

Mr. G. D. Hicks
Director - Nuclear Station Safety and Licensing
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. S. E. Scace
Assistant to the Site Vice President
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. Chris L. Funderburk
Director, Nuclear Licensing and
Operations Support
Dominion Resources Services, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

Millstone Power Station, Unit No. 2

cc:

Mr. A. J. Jordan, Jr.
Director - Nuclear Engineering
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. S. P. Sarver
Director - Nuclear Station Operations
and Maintenance
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

Mr. David W. Dodson
Licensing Supervisor
Dominion Nuclear Connecticut, Inc.
Rope Ferry Road
Waterford, CT 06385

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO RELIEF REQUEST RR-89-43

FOR TEMPORARY INSTALLATION OF MECHANICAL NOZZLE SEAL ASSEMBLIES ON

PRESSURIZER HEATER PENETRATION NOZZLES AT

MILLSTONE POWER STATION, UNIT NO. 2

DOMINION NUCLEAR CONNECTICUT, INC.

DOCKET NO. 50-336

1.0 INTRODUCTION

The inservice inspection of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g), except where specific written relief has been granted by the U.S. Nuclear Regulatory Commission (NRC) pursuant to 10 CFR 50.55a(g)(6)(i). Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

By letter dated August 11, 2003, Dominion Nuclear Connecticut, Inc. (DNC or the licensee) submitted Relief Request RR-89-43 for Millstone Power Station, Unit No. 2 (MP2). Pursuant to the provisions of 10 CFR 50.55a(a)(3)(i), the licensee's submittal requested approval for the temporary use of Mechanical Nozzle Seal Assemblies (MNSAs) in the repair of degraded pressurizer heater penetration nozzles as an alternative to certain requirements of Section XI of the ASME Code, 1989 Edition, no Addenda. As discussed in the licensee's letter dated August 11, 2003, the use of the MNSAs was proposed as a temporary repair for a time period not to exceed two operating cycles.

MNSAs are mechanical devices that are designed to fit around ASME Code Class 1 Alloy 600 nozzles as a means of preventing leakage past the nozzles. The MNSA design consists of two split gasket/flange assemblies. A gasket made from Grafoil packing, a graphite compound, is compressed within the gasket assembly to prevent reactor coolant system (RCS) pressure boundary leakage past the nozzle. The gasket assembly is bolted in place into holes that are drilled and threaded on the outer surface of the RCS pressure boundary wall. A second assembly is bolted to the flanges which serves as the structural attachment of the nozzle to the wall. The flange assembly serves to carry the loads in lieu of the partial penetration J-groove welds used to adjoin the nozzles to the particular RCS pressure boundary vessel or piping component of interest.

2.0 BACKGROUND

2.1 Licensee's Rationale for Relief Request

During the last refueling outage (RFO) at MP2 (i.e., RFO 14), evidence of primary water stress corrosion cracking (PWSCC) was detected on two pressurizer heater penetration nozzles. Temporary repairs were made to these nozzles by installation of MNSAs as authorized by the NRC in letters dated March 22, and June 19, 2002.

Based on experience with Alloy 600 nozzles at MP2 and throughout the industry, DNC believes a reasonable potential exists for future degradation from PWSCC in other pressurizer heater penetration nozzles as the service life of these components increases. Therefore, relief request RR-89-43 proposes to expand the applicability of the previously approved use of MNSAs at MP2 to the remaining pressurizer heater penetration nozzles, in the event that any of these nozzles are found to be degraded (i.e., leaking) during inspection in future RFOs.

The pressurizer heater penetration nozzles consist of a sleeve welded to the pressurizer bottom head with an internal J-groove weld. The typical permanent repair of these sleeves consists of either installing a heater sleeve plug welded to a temper-bead pad or a half-sleeve replacement. As discussed in the licensee's submittal, the typical repair methods for degraded pressurizer heater penetration nozzles are extremely difficult to implement on an emergent basis due to the system conditions required to perform the work and the limited time in which those conditions exist during an outage. These repairs would require the unplanned extension of drained down or defueled conditions and a significant increase in worker radiation exposure to perform the work on an emergent basis.

2.2 Regulatory Framework

Paragraph (g) of 10 CFR 50.55a requires, in part, that all inservice examinations and system pressure tests conducted during the first 10-year interval, and subsequent intervals, on ASME Code Class 1, 2, and 3 components comply with the requirements in the latest edition and addenda of Section XI incorporated by reference in 10 CFR 50.55a(b), on the date 12 months prior to the start of the 10-year interval. By reference to, and implementation of, ASME Code Section XI, paragraphs IWB-3132 or IWB-3142, 10 CFR 50.55a also requires that existing flaws in ASME Code Class components be removed by mechanical means, or the components be repaired or replaced to the extent necessary to meet the acceptance standards in ASME Code Section XI, Article IWB-3000. Detection of leaks in the structural portion of an ASME Code Class 1, 2, or 3 component is direct evidence of a flaw in the component.

Paragraph IWA-4170 of Section XI of the ASME Code requires that repairs and the installation of replacements to the RCS pressure boundary be performed and reconciled in accordance with the Owner's Design Specifications and Original Code of Construction for the component or system. The MP2 RCS pressurizer was designed and constructed to the rules of ASME Code, Section III, 1968 Edition with Addenda through Summer 1969.

Paragraph NB-3671.7 to Section III of the ASME Code, "Sleeve Coupled and Other Patented Joints," requires that ASME Code Class 1 joints be designed to meet the following criteria:

(1) provisions must be made to prevent separation of the joint under all service loading conditions,

(2) the joint must be designed to be accessible for maintenance, removal, and replacement activities, and

(3) the joint must either be designed in accordance with the rules of ASME Code, Section III, Subarticle NB-3200, or be evaluated using a prototype of the joint that will be subjected to additional performance tests in order to determine the safety of the joint under simulated service conditions.

These criteria also apply to the design, installation, inspection, and maintenance of MNSAs.

3.0 EVALUATION

The licensee requested the use of MNSAs pursuant to 10 CFR 50.55a(a)(3)(i), stating that this alternative provides an acceptable level of quality and safety. In order to determine if the MNSAs would provide an acceptable level of quality and safety, the staff compared the MNSA design and operational characteristics to the applicable ASME Code requirements, reviewed the MNSAs' resistance to corrosion for the intended service period, and evaluated the licensee's commitments associated with the use of the MNSAs.

MNSAs are designed, fabricated, and constructed using approved ASME Code materials (except for the Grafoil gasket, which is a non-Code material), in accordance with the applicable rules of ASME Code Section III. The MNSAs are designed to prevent separation of the gasket joint under all service conditions. In a letter dated March 15, 2002, DNC enclosed a proprietary Design Stress Report that was prepared by the MNSA manufacturer, Westinghouse Electric Company. The report provided a technical analysis of the MNSA for application to the pressurizer heater penetration nozzles, and also analyzed the impact of the MNSA installation on the design basis of the pressurizer. The report shows that the design of the MNSAs complies with the Design Criteria specified in the ASME Code Section III, Subsection NB, 1989 Edition, no Addenda, under all service conditions, applicable over a 40-year lifetime of plant operation. Since MNSAs are designed and built to a later Code edition, Attachment C, "ASME Code Reconciliation," to the report also documented the required ASME Section XI, IWA-4170(b), reconciliation of the Construction Code (ASME Code Section III, 1968, with Addenda through Summer 1969) with the Replacement Code (ASME Code Section III, Subsection NB, 1989 Edition, no Addenda) for the use of a component built to a later edition of the Code.

The staff did not evaluate the Design Stress Report with respect to the use of the pressurizer heater penetration nozzles MNSAs beyond a time period of two operating cycles. Based on its assessment, the staff considers the probability of exceeding the ASME Code, Section III, Class 1 fatigue cumulative limit of 1.0 in the short-term operation of two cycles to be very low. In addition, the operation of the MNSAs previously installed at MP2 appear to provide satisfactory service. Therefore, the staff concludes that the safety and structural integrity of the pressure vessel will not be compromised by the installation of MNSAs on an emergent basis for a period not exceeding two operating cycles. In the event that the licensee requests operation of already installed MNSAs beyond two cycles, the analysis contains several aspects which would require further staff in-depth review and evaluation before approval is granted for continuing operation.

The licensee also stated that MNSA installations are accessible for maintenance, removal, and replacement. The provisions of NB-3671.7 are, therefore, nominally satisfied.

In its letter dated August 11, 2003, DNC provided an evaluation to address potential corrosion issues associated with the application of the MNSAs to the pressurizer bottom head at MP2. The licensee's evaluation is as follows:

> <u>Erosion/Corrosion of Low Alloy Steel Components</u>
>
> A through-wall crack in the nozzle could be a source of erosion/corrosion. However, the borated water will stagnate in the annulus between the Inconel 600 nozzle sleeve and the low alloy steel component. In the absence of a replenishment mechanism, the boric acid and available oxygen will be consumed, and eventually the corrosion process will stop.
>
> <u>"J"-Weld Cracking</u>
>
> "J"-Weld cracking is fully addressed by the MNSA design, since the MNSA takes over the sealing and anti-ejection functions if the weld fails. The MNSA design qualification test runs included simulated partial cracks and complete 360 degree cracks in the nozzles.
>
> <u>Grafoil Seal Corrosion</u>
>
> The Grafoil seal material that is used in nuclear applications is composed of 99.5% graphite, with the remaining 0.5% made up of ash, halides, and sulfur (concerns for corrosion of low alloy steel). The Grafoil seal itself is chemically resistant to attack from nearly all organic and inorganic fluids, and is very resistant to borated water. Galvanic corrosion can occur between two materials that are electrically connected and have a measurable voltage potential difference as noted by the two materials positions in the electromotive series. Graphite is very high on the electromotive series (cathode) and carbon steel is much lower on the electromotive series (anode). However the conductivity of primary water is quite low so that there is not enough of a current flow to cause galvanic corrosion. Graphite gaskets and seals are used extensively in both the primary and secondary systems of PWRs [pressurized water reactors] without galvanic corrosion.
>
> <u>Hardware Corrosion</u>
>
> All the components of the MNSA are fabricated from corrosion resistant materials. Most components are 300 series stainless steel. Fasteners and tie rods are made from SA-453 Grade 660 (a [precipitation] hardened austenitic stainless steel). Boric acid corrosion of the materials of construction for the MNSA and the outer surfaces of the vessel has been assessed by Combustion Engineering Owners Group (CEOG) and

through other testing and analysis. With the current ASME Section XI required inspections, a leaking MNSA would be detected before significant corrosion of the pressurizer bottom head occurs. If the MNSA device leaks, the bolts may be exposed to borated water or steam under conditions in which deposits or slurries will develop. At stress levels present in the MNSA application, these bolts will operate satisfactorily for more than one fuel cycle. The leaking MNSA will be discovered and repaired as part of the Boric Acid Corrosion Control Program walkdown inspections, limiting the exposure to these conditions to a cycle or less.

Based on review of the licensee's evaluation of potential corrosion effects, the staff concludes that there are no significant corrosion issues associated with the application of the MNSAs to the MP2 pressurizer heater penetration nozzles over the requested two-cycle period of use.

The licensee's submittal provided the following information regarding the installation, inspection, and testing of the MNSAs:

(1) The licensee will perform a visual examination of any leaking nozzles. An informational ultrasonic test will be performed to determine the thickness measurement near the nozzles. A comparison of the data will be made between the leaking and non-leaking penetrations to evaluate if any measurable corrosion damage is present around the leaking nozzles.

(2) The licensee's installation procedure for the MNSAs contains instructions/guidance to ensure that the surface of the pressurizer is in a condition such that the MNSA will seal correctly.

(3) As required by IWA-4600, a VT-1 preservice inspection will be performed on all MNSA installations in accordance with IWB-2200.

(4) During plant startup (Mode 3), after initial MNSA installation and during subsequent plant restarts following a refueling outage, the pressurizer heater penetration nozzle MNSAs will be pressure tested and inspected for leakage. To ensure quality of the installation and continued operation with the absence of leakage, a pressure test with VT-2 visual examination will be performed on each of the installed MNSAs with any insulation removed. The test will be performed as part of plant restart and will be conducted at normal operating pressure with the test temperature determined in accordance with the pressure and temperature limits as stated in the MP2 Technical Specifications. Additionally, VT-3 exams will be performed to verify general structural and mechanical condition of the MNSAs.

The staff has reviewed the licensee's submittal with respect to the installation, inspection, and testing of the MNSAs. The staff concludes that these actions are sufficient to ensure proper installation and operation of the MNSAs for their intended use for a period not to exceed two operating cycles.

4.0 CONCLUSION

Based on the preceding evaluation, the NRC staff concludes that the proposed alternative to the ASME Code requirements described in Relief Request RR-89-43 will provide an acceptable level of quality and safety for repair of pressurizer heater penetration nozzles at MP2 for a time period not to exceed two operating cycles. Therefore, the alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(i). Since DNC's request was proposed as a contingency in the event any degraded pressurizer heater penetration nozzles are found in future outages, the staff authorizes the proposed alternative for installation of MNSAs, on an as-needed basis, for the time period commencing with the fall 2003 RFO (i.e., RFO 15) through the completion of RFO 16. In all cases, each MNSA is authorized as a temporary repair for a period not to exceed two cycles from the initial installation date.

Principal Contributor: M. Hartzman

Date: October 28, 2003