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A. Edward Scherer
Manager of
Nuclear Regulatory Affairs

January 24, 2003

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Subject: **Docket Nos. 50-361 and 50-362**
Mechanical Nozzle Seal Assembly Type 2 Code Replacement
Request for Relief from 10 CFR 50.55a
San Onofre Nuclear Generating Station, Units 2 and 3

Dear Sir or Madam:

Pursuant to 10CFR50.55a(a)(3)(i), Southern California Edison (SCE) requests NRC authorization to use a new design of the Mechanical Nozzle Seal Assembly (MNSA-2) in temporary applications as documented in Request for Alternative MNSA-2-Cycle 12 (see Enclosure 1). SCE intends to utilize MNSA-2s on Pressurizer Heaters sleeves found to be exhibiting leakage due to Primary Water Stress Corrosion Cracking (PWSCC) at San Onofre Nuclear Generating Station (SONGS) Units 2 and 3. The use of the MNSA-2 covered by this request will be limited to Cycle 12 operation. SCE will be changing from the 2nd ten-year Inservice Inspection (ISI) Interval to the 3rd ten-year ISI interval on August 18, 2003. To support the 3rd ten-year interval SCE will include a relief request for use of the MNSA-2 through Cycle 13, and SCE is continuing to evaluate the use of the MNSA-2 for permanent application and may seek such relief in the future.

SCE has concluded that use of MNSA-2s for restoring structural integrity and leak tightness to the RCS provides an acceptable level of safety and quality. The NRC previously authorized temporary use of the original MNSA design at SONGS 2 and 3, at Waterford 3, at Palo Verde Nuclear Generating Station and at Millstone Nuclear Power Station. The NRC staff previously authorized use of the MNSA-2 design at Waterford and at Arkansas Nuclear One.

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During the current refueling outage at SONGS Unit 3, SCE inspected the small-bore nozzles on the pressurizer; specifically, 30 heater sleeves. During this inspection, SCE did not detect evidence of leaking pressurizer nozzles; however, we are submitting this request in order to proactively prepare for possible leaks that may be detected during re-start of Unit 3. Using the MNSA-2 as an alternative repair on a nozzle during the Unit 3 re-start would result in a potential savings of 4 to 8 days of critical path time and approximately 1.5 to 2 person rem. Using the MNSA-2 as an alternative repair in this circumstance has a cost benefit of over $3 million. Therefore, SCE requests that the NRC approve MNSA-2-Cycle 12, before Mode 4, which is currently scheduled for February 9, 2003, in order to support these inspection activities. Following installation of the first MNSA-2 at SONGS, SCE will incorporate this alternative into the SONGS 2 and 3 Inservice Inspection (ISI) Plan.

To assist the Staff with its review of MNSA-2-Cycle 12, SCE is also providing supporting information in Enclosures 3 through 8. As supporting documents, these enclosures are not considered part of MNSA-2-Cycle 12 and will not be incorporated into the SONGS 2 and 3 ISI Plan. Enclosures 3 through 8 contain engineering reports and information regarding testing for the MNSA-2 design.

The MNSA-2 vendor, Westinghouse, considers the information contained in Enclosures 3 through 7 to be proprietary and confidential pursuant to 10CFR2.790(a)(4) and 10CFR 9.17(a)(4). As such, SCE requests this information be withheld from public disclosure. The affidavit supporting this request is provided in Enclosure 2. Because the vast majority of the information contained in the attachments is considered proprietary, it is not practical to provide nonproprietary versions.

This letter contains a commitment to incorporate this alternative into the SONGS 2 and 3 inspection programs.

If you have any questions or would like additional information concerning this subject, please call Mr. Jack Rainsberry (949) 368-7420.

Sincerely,

Enclosures

cc: E. W. Merschoff, Regional Administrator, NRC Region IV
B. M. Pham, NRC Project Manager, San Onofre Units 2, and 3
C. C. Osterholtz, NRC Senior Resident Inspector, San Onofre Units 2 & 3

ENCLOSURES:

1. ISI Relief Request MNSA-2-Cycle 12

2. Affidavit for Withholding Information from Public Disclosure

3. Westinghouse Calculation Number CN-CI-02-76 Rev. 0 "Analysis of SONGS Unit 2 & 3 Pressurizer Heater Sleeve MNSA-2 Designs," dated 1/10/03

4. Westinghouse Test Report Number TR-CI-02-4, "Seismic Qualification Testing of the SONGS, Units 2 & 3 MNSA-2 Clamps for Pressurizer Heaters" dated 01/10/03.

5. Westinghouse Calculation Number CN-CI-02-73 Rev. 00, "Evaluation of Attachment Locations for the Mechanical Nozzle Seal Assemblies on SONGS Unit 2 and 3 Pressurizer Heater Sleeves," dated 1/10/03

6. Westinghouse Design Report Number DAR-CI-02-21, Rev. 0, "Addendum to CENC-1275 and CENC-1296 Analytical Reports for Southern California Edison San Onofre Units 2 and 3 Pressurizer," dated 1/10/03

7. Westinghouse Report DS-ME-02-8, rev. 01, "Design Specification for Mechanical Nozzle Seal Assembly (MNSA2) for San Onofre Units 2 and 3."

8. Letter dated March 1, 2002 from Michael A. Krups to US Nuclear Regulatory Commission; subject: "Entergy operations, Inc. Use of Mechanical Nozzle Seal Assemblies Waterford Steam Electric Station – Unit 3 Docket No. 50-382 License NPF-38" (reference CNRO-2220-0001) – Cover letter and Attachment 1 only.

Enclosure 2

Affidavit for Withholding Information from Public Disclosure

I, Ian C. Rickard, depose and say that I am the Licensing Project Manager of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.

This affidavit is submitted in conjunction with the application by Southern California Edison and in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding proprietary information. The information for which proprietary treatment is sought, and which documents have been appropriately designated as proprietary, is:

- *Westinghouse Design Report DAR-CI-02-21, Rev 0, "Addendum to CENC-1275 and CENC-1296 Analytical Reports for Southern California Edison San Onofre Units 2 and 3 Pressurizer," dated January 10, 2003, including:*
  - *Calculation CN-CI-02-76, Rev 0, "Analysis of SONGS Unit 2 & 3 Pressurizer Heater Sleeve MNSA-2 Designs," dated January 10, 2003, and*
  - *Calculation CN-CI-02-73, Rev 00, "Evaluation of Attachment Locations for the Mechanical Nozzle Seal Assemblies on SONGS Unit 2 and 3 Pressurizer Heater Sleeves," dated January 10, 2003.*
- *Westinghouse Test Report TR-CI-02-4, Rev 0, "Seismic Qualification Testing of the SONGS, Units 2 & 3 MNSA-2 Clamps for Pressurizer Heaters," dated January 10, 2003.*
- *Westinghouse Report DS-ME-02-8, Rev 01, "Design Specification for Mechanical Nozzle Seal Assembly (MNSA2) for San Onofre Units 2 and 3," dated January 8, 2003.*

Pursuant to 10 CFR 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the documents listed above should be withheld from public disclosure.

1. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of an evaluation and qualification of mechanical nozzle seal assemblies used in the repair of pressurizer heater sleeves at San Onofre Units 2 and 3.
2. The information consists of analyses or other similar data concerning a process, method or component, the application of which results in substantial competitive advantage to WEC.
3. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.
4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
6. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:
   a. A similar product or service is provided by major competitors of Westinghouse.
   b. WEC has invested substantial funds and engineering resources in the development of this information. A competitor would have to undergo similar expense in generating equivalent information.

c. The information consists of evaluations, design calculations, design reports and qualification of mechanical nozzle seal assemblies used in the repair of pressurizer heater sleeves at San Onofre Units 2 and 3, the application of which provides Westinghouse a competitive economic advantage. The availability of such information to competitors would enable them to design their product or service to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.

d. Significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included in pricing WEC's products and services. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

e. Use of the information by competitors in the international marketplace would increase their ability to market comparable products or services by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on WEC's potential for obtaining or maintaining foreign licenses.

Ian C. Rickard
Licensing Project Manager
Westinghouse Electric Company LLC

Sworn to before me this 20th day of January 2003.

Linda A. Scott Notary Public

My commission expires: May 31, 2003

Enclosure 1

ISI Relief Request

MNSA-2-Cycle 12

TABLE OF CONTENTS

I. COMPONENTS

Description: Pressurizer Heater Sleeves. Thirty (30) total per Unit.

Code Class: ASME Section III, Class 1

References:

1. ASME Section III, 1989 Edition, no Addenda (MNSA-2 Design Code)
2. ASME Section III, 1971 Edition through and including Summer 1971 Addenda (Pressurizer Design Code)
3. ASME B&PV Code, Section XI, 1989 Edition, no Addenda
4. Westinghouse Calculation Number CN-CI-02-76 Rev. 0 "Analysis of SONGS Unit 2 & 3 Pressurizer Heater Sleeve MNSA-2 Designs," dated 1/10/03
5. Westinghouse Test Report Number TR-CI-02-4, "Seismic Qualification Testing of the SONGS, Units 2 & 3 MNSA-2 Clamps for Pressurizer Heaters" dated 01/10/03.
6. Westinghouse Calculation Number CN-CI-02-73 Rev. 00, "Evaluation of Attachment Locations for the Mechanical Nozzle Seal Assemblies on SONGS Unit 2 and 3 Pressurizer Heater Sleeves," dated 1/10/03
7. Westinghouse Design Report Number DAR-CI-02-21, Rev. 0, "Addendum to CENC-1275 and CENC-1296 Analytical Reports for Southern California Edison San Onofre Units 2 and 3 Pressurizer," dated 1/10/03
8. Letter dated March 1, 2002 from Michael A. Krups to US Nuclear Regulatory Commission; subject: "Entergy operations, Inc. Use of Mechanical Nozzle Seal Assemblies Waterford Steam Electric Station – Unit 3 Docket No. 50-382 License NPF-38" (reference CNRO-2220-00010)
9. Westinghouse Report DS-ME-02-8, rev. 01, "Design Specification for Mechanical Nozzle Seal Assembly (MNSA2) for San Onofre Units 2 and 3."
10. Letter dated January 17, 2003 from A. E. Scherer (SCE) to the Document Control Desk (NRC); Subject: Docket Nos. 50-361 and 50-362, Response to NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," 60-Day Response for San Onofre Nuclear Generating Station, Units 2 and 3, Request for Additional Information (TAC Nos. M4575 and M4576)

Unit/Inspection Interval/Applicability

San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 are both in their second 10-year Inservice Inspection (ISI) interval. The current "Code of Record" for Inservice Inspection is the ASME B&PV Code, Section XI, 1989 Edition, no Addenda (Reference 3). On August 18, 2003, SONGS Units 2 and 3 will begin their third 10-year ISI interval and the ASME Code of Record will change to the 1995 Edition; 1996 Addenda.

II. CODE REQUIREMENTS

ASME Section XI, (reference 3) IWA-7200 requires any items used for replacements to be performed in accordance with the existing design requirements and the original Construction Code of the component or system. The affected pressurizer heater sleeves were designed and constructed to the rules of ASME Section III, Subsection NB, 1971 Edition, through and including the Summer 1971 Addenda (Reference 2). ASME Section XI does not include rules that address the use of mechanical clamping devices to control leakage through the pressure boundary and to maintain the structural integrity of the ASME III, Class 1 pressure retaining boundary.

III. PROPOSED ALTERNATIVE

Pursuant to 10CFR50.55a(a)(3)(i), Southern California Edison (SCE) requests NRC authorization to use the improved design of the Mechanical Nozzle Seal Assembly, designated MNSA-2, in applications at the heater sleeves located on the bottom head of the pressurizer vessels at SONGS Units 2 & 3.

SCE makes this request in order to repair leaks attributed to Primary Water Stress Corrosion Cracking (PWSCC) that may be detected while performing inspections during refueling outages.

The typical repair of nozzles or heater sleeves of this type uses a half-nozzle replacement with external weld repair. These repairs would extend reactor coolant system (RCS) drain-down activities or require de-fueled conditions and significantly increase worker radiation exposure to perform extensive field machining and temper bead welding activities.

As an alternative, SCE proposes to use the MNSA-2 as a repair to restore heater sleeve integrity and prevent leakage.

IV. BASIS FOR PROPOSED ALTERNATIVE

A. *Background*

The pressurizer, including the heater sleeve penetration assemblies, was designed by Combustion Engineering. Combustion Engineering is currently owned by Westinghouse Electric Company.

- Pressurizer heater sleeves (30)

The pressurizer heater sleeves, thirty (30) on each Unit's pressurizer, are manufactured from Ni-Cr-Fe, SB-167 material (Inconel 600). One heater sleeve at SONGS 3 has a half nozzle welded to the exterior of the vessel. The remaining 30 heater sleeves at SONGS Unit 2 and 29 heater sleeves at SONGS Unit 3 are welded to the internal cladding of the vessel lower head and the heater elements are welded to the lower end of the sleeves. The heater elements are internally supported for seismic loading and vibration by two heater support plates. The outside diameter of the sleeve is approximately 1.660 inches, and the inside bore is approximately 1.273 inches. The length of the sleeves varies from approximately 14 3/8 inches long to approximately 18 3/8 inches long, depending on the location on the bottom head. The upper end of the heater sleeve is provided with a short oversize segment to serve as an anti-ejection device should the sleeve to vessel weld fail completely.

- Pressurizer Vessel

The pressurizer is a low alloy steel vessel with the shell and top head internally clad with 304 austenitic stainless steel and the bottom head with a Ni-Cr-Fe cladding.

The Ni-Cr-Fe heat affected zone of the J-weld has proven to be susceptible to PWSCC. Numerous instances of nozzle cracking have been identified in the industry in recent years. Studies performed by the Westinghouse Owner's Group (Report CENPSD-690-P) have found that the cracking growth is predominantly axial. The dominant condition that promotes axial growth rather than circumferential growth is high circumferential stress (hoop stress) compared to the axial stress. The hoop stress is a residual stress caused by weld shrinkage that diminishes quickly as the distance from the J-weld increases. The susceptibility to cracking is based on several factors that deal with material, stress, and environment.

Inspections required by ASME Section XI, IWB-2500 for Examination Category B-P are performed during each refueling outage. Additionally, the walkdown inspections performed in response to Generic Letter 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Coolant Pressure Boundary Components" as recommended by the Combustion Engineering Owner's Group have been performed.

B. MNSA-2 Application, Description, and Design

1. Overview

The MNSA-2 is a mechanical device designed to replace the function of partial penetration J-groove welds that attach Alloy 600 nozzles or heater sleeves to the pressurizer. MNSA-2 provides a seal against leakage and positively captures the sleeve preventing ejection in the unlikely event of complete 360-degree weld failure. Figure 1 shows a representative drawing of the MNSA-2 for a heater sleeve.

To install the MNSA-2, four holes are drilled and tapped (1/2" diameter x 1 1/2" deep) equally spaced around the leaking sleeve. A counter-bore (approximately 1/4" wide x 3/4" deep) is also machined into the surface of the vessel perpendicular to and around the leaking sleeve. Four threaded rod studs are threaded into the pressurizer, a split Grafoil primary seal is installed in the bottom of the counter-bore, and a split compression collar is placed over the nozzle or sleeve to compress the Grafoil seal. The seal assembly is compressively loaded via the compression collar and the inboard and outboard flange assembly, which is in the annulus region. Hex nuts and Belleville spring washers are used to live load the Grafoil seal to accommodate small changes in load on the seal due to differential expansion or minute relaxation of the seal over time and prevent seal leakage.

To prevent heater sleeve ejection in the unlikely event of a complete sleeve weld failure, an anti-ejection clamp is also installed and secured in place via the tie rods, Belleville spring washers, and hex nuts. The anti-ejection clamp acts as a restraint only if the sleeve or partial penetration weld completely fails.

More specific details of the MNSA-2 design are provided in Section B.2, below.

2. Design

The NRC previously authorized use of the MNSA-2 design for nozzles and sleeves at Waterford 3. The NRC has approved similar requests for temporary repair of pressurizer instrument nozzles and heater sleeves by MNSA (the original design) at Southern California Edison's San Onofre Nuclear Generating Station; Entergy Operations Inc.'s Waterford 3; Arizona Public Service Company's Palo Verde Nuclear Generating Station; and at Dominion Nuclear Connecticut's Millstone Nuclear Power Station.

The original MNSA and MNSA-2 use the same materials of construction and the same seal material. They are attached in the same fashion, and the seal is loaded by tensioning bolts or studs.

The MNSA-2 design differs from the original MNSA design in three ways:

- The counter-bore provision that contains the seal
- The manner in which the seal is live-loaded
- The means for diverting leakage, should it occur

Each is discussed in detail below.

a) Counter-Bore Provision

MNSA-2 uses nuclear grade Grafoil as the sealing material. In all cases, regardless of the angle of the surface of the pressurizer relative to the sleeve, a counter-bore is machined perpendicular to the sleeve to receive and contain the seal. The bottom of the counter-bore is perpendicular to the axis of the sleeve, so the angle of the surface of the pressurizer does not affect the leak tightness of the design. When the MNSA-2 seal is compressed, no side loads are introduced, so shoulder bolts used on the original MNSA are not required. The seal designs are simpler than the original MNSA because they involve no variable angles. Therefore, customizing MNSA components for particular slope angles, for other than bolt lengths, is not required.

b) Seal Live-Loading

MNSA-2 uses a live-loaded seal that can accommodate small changes in load on the seal due to differential expansion. The live load provision, provided via Belleville washers, also accommodates minute relaxation of the seal over time to prevent leakage. Finally, it allows for re-tightening of the studs and reloading the seal at some point in the future without disassembly, whereas the original MNSA would require a new seal and complete teardown and re-assembly to reenergize a seal. Figure 1 shows the use of Belleville spring washers.

c) Leak-Off Diversion

Leakage control in the MNSA-2 design is accomplished by using a compression collar which includes a collection area (similar to a "lantern ring") positioned immediately outboard of the primary seal, as shown in Figure 1. The compression collar has an additional Grafoil seal at the top that is lightly loaded. The seal blocks leakage from passing up along the outside of the compression collar where it could reach the threaded rods. The path of least resistance is out through the annulus between the compression collar and the sleeve, tending to divert any leakage away from the fasteners and the vessel. The presence of the collection area does not impair the primary seal in any way.

In the review of the original MNSA design, the NRC evaluated potential corrosion effects of boric acid on the MNSA and associated RCS components. The evaluation considered:

- Corrosion of the low alloy material with a MNSA installed was determined to be acceptable

- Boric acid corrosion of the materials of construction for the MNSA was determined to be acceptable based on CE Owner's Group corrosion testing

- There is no history of galvanic corrosion problems in similar applications with Grafoil contacting low alloy steel.

- Potential for SCC failures of the SA 453 Grade 660(A-286) bolts was found to be acceptable

There are no changes from the original MNSA to MNSA-2 that adversely impact the four conclusions listed above. With regard to the SA 453 Grade 660 (A-286) bolts, the NRC evaluation concluded that the bolts could be exposed to boric acid deposits or slurries, if the MNSA leaks. This evaluation was appropriate because the design did not include provisions for capturing or diverting seal leakage away from bolting materials. Regardless, at the stress levels that exist in the bolts, including a stress concentration factor of four, the bolts would function satisfactorily.

In contrast to the original MNSA, the MNSA-2 design includes specific provisions to divert potential seal leakage away from the low alloy steel vessel and the bolting as described below.

The sealing qualities of MNSA-2 are enhanced beyond that of the original MNSA by virtue of the controlled geometry (counter-bore), and by maintaining a live load on the seal. The counter-bore design has been used routinely in hundreds of similar applications for sealing fixed in-core detectors to flanges on the reactor head in Combustion Engineering units. A variety of other repairs and permanent flange upgrades have been installed on both Combustion Engineering and Westinghouse units using both static and live-loaded Grafoil seal technology. Therefore, the possibility of a leak past the primary seal is very small. Nevertheless, in the unlikely event of such a leak, MNSA-2 is designed to limit exposure of the SA-453 grade 660 (A-286) bolting material and the carbon steel vessel by providing a leak-off path.

d) Installation

The MNSA-2 installation process will be performed such that it will not degrade the existing heater sleeve pressure boundary, and it does not require draining of the pressurizer to install. The tooling is designed to machine the counter-bore without disconnecting the pressure boundary heater element.

Torquing the MNSA threaded rods into the pressurizer will be performed at temperatures above RT_{NDT} (10 °F for the bottom head) to ensure the bolting stress does not create a potential for brittle failure. The stress calculations (References 4 and 6) document the installation torque values of 27 ft-lbs for the threaded rods. Pre-load conditions are addressed in the installation procedures.

3. MNSA-2 Materials

The MNSA-2 assembly is fabricated from the same materials as the original MNSA, though with different application of some of the components. A detailed assessment of the MNSA-2 metallic components as related to general corrosion, stress corrosion cracking of nozzles and fasteners, galvanic effects, crevice corrosion, and surface pitting of the constituent components is contained in Appendix 1of this relief request. There are no potential corrosion problems associated with the application of the MNSA-2 to Alloy 600 small diameter heater sleeves.

The stainless steel portions of the MNSA-2 performing an RCS pressure boundary function are manufactured in accordance with material specifications provided in ASME Section III, Subsection NB and the applicable ASME Section III Appendices. Additionally, the material meets the requirements contained in NB-2000 including examination and testing. Materials are supplied to the provisions of ASME Section III, NCA-3800 by suppliers maintaining a valid Quality System Certificate or a Certificate of Authorization with the scope of Material Supply. Metallic pressure boundary material is certified in accordance with ASME Section III, NCA-3800.

The primary Grafoil seal material is Grade GTJ (used in nuclear applications) composed of 99.5% graphite, with the remaining 0.5% made up of ash, halides, and sulfur. The Grafoil seal itself is chemically resistant to attack from organic and inorganic fluids, and is very resistant to borated water. Similar Grafoil material is used as valve packing in valves installed in the RCS with acceptable results. The Grafoil material is provided under the provisions of a Quality Assurance Program meeting 10CFR50 Appendix B that has been approved by SCE. Material testing and certification is provided with the material to verify compliance with the engineered features that are required to ensure functionality and compatibility with the pressure boundary materials and environment.

In summary, there are no potential corrosion or material stress issues associated with applying the MNSA-2 to the pressurizer heater sleeves.

4. MNSA-2 Structural Evaluation

The component parts of the MNSA-2 for heater sleeve are analyzed, designed, and manufactured in accordance with ASME Section III, Subsection NB, 1989 Edition, which is approved in 10 CFR 50.55a. The SONGS original Construction Code for the pressurizer is ASME Section III, 1971 Edition (Reference 2), through and including the Summer 1971 Addenda. As required by ASME Section XI, an addendum to the SONGS Units 2 and 3 Pressurizer Stress Reports CENC 1275 and CENC 1296 (Reference 7) was completed and includes a reconciliation for use of the 1989 Edition of ASME Section III (Reference 1) as it applies to the MNSA-2 and its interface with the pressurizer.

The analysis for the MNSA-2 components addressed:

- Stresses not to exceed the allowables as stated in the Code.
- Fatigue to demonstrate that the Code-prescribed cumulative usage factor of 1.0 is not exceeded (NB-3222.4) for any component

The stress analysis considered the loads transmitted to the components of the MNSA-2 due to installation pre-load, normal and upset loads at pressure and temperature, and impact loads due to the ejection of the heater sleeve in the unlikely event of a complete failure of the J-weld. The results of the stress analysis demonstrate that the applied stresses on each load-bearing component (tie rods, threaded rods, and top plate) are below the applicable Code allowables, thereby providing assurance of structural integrity for the MNSA-2.

Fatigue evaluations of the MNSA-2 clamp components considered a forty-year design life. The calculated fatigue usage factors in Reference 6 are less than 1.0 for MNSA-2 components. The primary component of the usage factors is the stress range between heat-up and cooldown conditions. However, for two cycles of operation, the expected numbers of heat-up and cooldown cycles are substantially less than those accounted for in the stress analysis for a 40-year design life.

5. Pressurizer Modification and Structural Evaluation

The MNSA-2 is attached to the pressurizer with SA-453 Grade 660 threaded rods and hex nuts. To accommodate the threaded rods, four holes are drilled and tapped into the pressurizer in a circular pattern around the sleeve. To provide a seating surface for the Grafoil seal, a counter-bore is machined into the pressurizer extending out approximately ¼" from the existing sleeve bore and to a maximum depth of ¾". The addition of the holes in the pressurizer was analyzed and documented in an attachment to the Westinghouse calculation CN-CI-02-73 (Reference 6) for the heater sleeve locations. The analysis is performed to the requirements of ASME Section III, 1971 Edition through and including the Summer 1971 Addenda. The analysis addresses:

- Stresses not to exceed the allowables as stated in the Code.
- Fatigue to demonstrate that the Code prescribed cumulative usage factor of 1.0 is not exceeded (NB-3222.4) at any location.
- Adequate reinforcement in the wall of the pressurizer for the tapped holes and counter-bore exists (NB-3330)

The stress analysis considered all loads evaluated in the original design stress report, including all pressure and temperature transients, the differential thermal expansion loads due to the threaded rods in the tapped holes, compression collar loads, and the loads on the existing J-weld at operating and during shutdown conditions. The applied stresses and stress ranges were evaluated at the counter-bore region and at the tapped holes for compliance with Code allowables. The applied stresses on the pressurizer were modified by the appropriate geometry factors for non-radial effects (where applicable) and by additional factors to take into account stress interaction between the tapped holes and the counter-bore as determined by finite element analysis (FEA). The results of the stress analysis, considering the tapped holes and counter-bore in the pressurizer shell, demonstrate applied stresses are below ASME Code allowables and provide assurance of vessel structural integrity.

Fatigue evaluations of the pressurizer shell in the vicinity of the tapped holes and counter-bores considered a forty-year design life. The calculated fatigue usage factors in Reference 6 are less than 1.0 in the vicinity of the tapped holes and counterbores for any location subject to MNSA-2 installation. The primary component of the usage factors is the stress range between heat-up and cooldown conditions. However, for two cycles of operation, the expected number of heat-up and cooldown cycles are substantially less than those accounted for in the stress analysis for a 40-year design life.

The area reinforcement calculations performed in the original design stress report in accordance with ASME Code Section III NB-3330 were updated to evaluate the removal of pressurizer metal area by machining the tapped holes and counter-bores. The results of the analysis in Reference 6 showed that for each pressurizer heater sleeve location evaluated for possible MNSA-2 installation, the area available for reinforcement is greater than the area required as a result of metal removal.

C. MNSA-2 Design Requirements

In accordance with ASME Section XI, IWA-7200, replacements shall meet the existing design requirements and the original Construction Code. Alternatively, replacements may meet later Editions of the original Construction Code provided:

- The requirements affecting the design, fabrication, and examination of the item to be used for replacement are reconciled with the Owner's through the Stress Analysis Report, the Design Report, or other suitable method that demonstrates the item is satisfactory for the specified design and operating conditions.

- Mechanical interfaces, fits, and tolerances that provide satisfactory performance are compatible with the system and component requirements.

- Materials are compatible with installation and system requirements.

ASME Section III NB-3200 rules are followed for designing and manufacturing the MNSA-2. Specifically, the joints will be designed to meet the following criteria:

1. Provisions must be made to prevent separation of the joint under all service conditions.

2. The joint must be designed to be accessible for maintenance, removal, and replacement activities.

3. The joint must either be designed in accordance with the rules of ASME 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 topics are discussed below.

1. Joint Integrity

In addition to the prototype testing discussed below, the MNSA-2 is analyzed to meet the requirements of NB-3200. The MNSA-2 is designed as an ASME Section III, Class 1, safety-related primary pressure boundary in accordance with the rules of NB-3200 to prevent joint separation under service loads. An addendum to Pressurizer Stress Reports CENC-1275 and CENC-1296 for SONGS Units 2 and 3 (Reference 7) demonstrates that stresses under all service conditions do not exceed the Code allowables as stated within Section III and that fatigue limits are not exceeded using the conditions contained in the Design Specification.

2. Maintenance, Removal, and Replacement

Typical for mechanical connections, the MNSA-2 will be accessible for maintenance, removal, and replacement after service. The MNSA-2 is manufactured without welding and is bolted in place, so disassembly is a mechanical evolution that requires de-tensioning the installation bolting.

3. Qualification Testing

The original MNSA design was qualified by a series of tests and analyses. Entergy Operations, Inc. in their submittal for MNSA-2 (Reference 8) said that they performed hydrostatic and thermal cycling prototype tests.

Seismic Qualification Testing:

Seismic qualification was performed for the SONGS MNSA-2 assembly in accordance with the guidelines in IEEE-344. A test specimen representative of an outer heater sleeve MNSA-2 design for SONGS Units 2 and 3 was attached to an adapter plate and mounted to a shaker table. The heater sleeve test specimen was not welded to the mounting fixtures. The MNSA-2 components were assembled and installed onto the simulated heater sleeve mock-up. The seismic testing consisted of subjecting the MNSA-2 test rig to five operating basis earthquake events and one safe shutdown earthquake event. The mounting fixture permitted pressurization to 3,175 psig ± 50 psig at ambient temperature during the seismic test. This elevated pressure was conservatively used to account for the fact that the seismic testing was performed at ambient temperatures rather than operating temperatures. The test results indicate that no mechanical damage occurred and no leakage was present. Information contained in Reference 5 provides a basis for performing the seismic testing using ambient temperatures and concludes that the test results were applicable to hot conditions.

Summary:

The test program, test results, and analyses described in References 4, 5, 6, 7 and 8 have been reviewed and found to adequately represent or bound the conditions for which SCE proposes to install the MNSA-2 at SONGS Units 2 and 3.

The MNSA-2s to be installed at SONGS Units 2 and 3 will be subjected to the conditions described below which are obtained from the Design Specification (Reference 9) and form part of the basis for analysis. As evidenced by design analyses (References 4, 6, & 7), and seismic test report (Reference 5), the design conditions equal or exceed the operating conditions for which the clamps will be exposed.

	SONGS 2/3 Conditions	MNSA-2 Design
Design Pressure	2500 psia	2500 psia
Design Temperature (Pressurizer)	700°F	700°F
Nominal Operating Pressure	2250 psia	
Normal Temperature (Pressurizer)	653°F	

D. Inservice Testing and Inspection

1. ASME Section XI Preservice

ASME Code Section XI Preservice inspection requirements, applicable to the MNSA-2 during each 10-year inspection (ISI) interval, include a system leak test at the end of each refueling outage and bolting examination, based on the schedule of percentages required. For the MNSA-2 installed on pressurizer heater sleeves, the Bolting B-G-2 examination requirements would allow VT-1 examination to be performed as follows: (a) in place under tension, and (b) when the connection is disassembled or when the bolting is removed. This examination is required once each ten-year interval.

2. ASME Section XI Pressure Tests

A VT-2 examination will be performed in conjunction with a system leakage pressure test (per IWA-5000) as part of plant re-start and will be conducted at normal operating pressure and temperature for SONGS Unit 2 and 3 Pressure and Temperature Limits as stated in the applicable Technical Specifications.

3. ASME Section XI Inservice Inspection

The VT- 1 inservice inspections required by ASME Section XI for Examination Category B-G-2 are performed during each refueling over the I0-year interval and would not be performed more frequently than during refueling cycles. The VT-2 inspection required by ASME Section XI for Examination Category B-P is required to be performed prior to plant startup following each refueling outage.

Bounding flaw evaluation will be performed for all pressurizer heater sleeves in accordance with the 1989 ASME section XI Code, IWB-3600. Existing site-specific bounding flaw evaluations will be updated to address the installation of a MNSA-2 clamp. Flaw growth due to fatigue and stress corrosion cracking has been previously considered and will be re-evaluated for potential MNSA-2 effects.

E. Additional Outage Inspections

After a MNSA-2 is installed, it will included in the SONGS Boric Acid Leakage Program and Alloy 600 Inspection Program. These programs were recently discussed in detail in the SCE response to a request for additional information regarding Bulletin 2002-02 (Reference 10).

Additionally, SCE will visually inspect for leakage the counter-bore/annulus region of each installed MNSA-2 device during each refueling outage.

V. CONCLUSION

10CFR50.55a(a)(3) states:

"Proposed alternatives to the requirements of(c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety, or

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

SCE believes that the proposed alternative provides an acceptable level of quality and safety because:

- The design of the MNSA-2 is in accordance with ASME Section III, 1989 Edition (Reference 1), NB-3200. The analysis includes provisions for fatigue and assurances that stresses do not exceed Code allowables. Additionally, significant prototype testing (seismic, hydrostatic, and thermal cycling) has been completed that demonstrates functionality and leak tightness during conditions of operations that are representative of SONGS.

- Modification of the Pressurizer was analyzed in accordance with the original Construction Code (ASME Section III, 1971 Edition through and including the Summer 1971 Addenda). Analysis included fatigue, reinforcement requirements for the tapped holes and counterbores, and assurance that stresses do not exceed Code allowables.

- Methods of analysis, materials, and fabrication meet ASME Section III, Subsection NB. This is comparable to the original methods of analysis, materials and fabrication used for the Pressurizer.

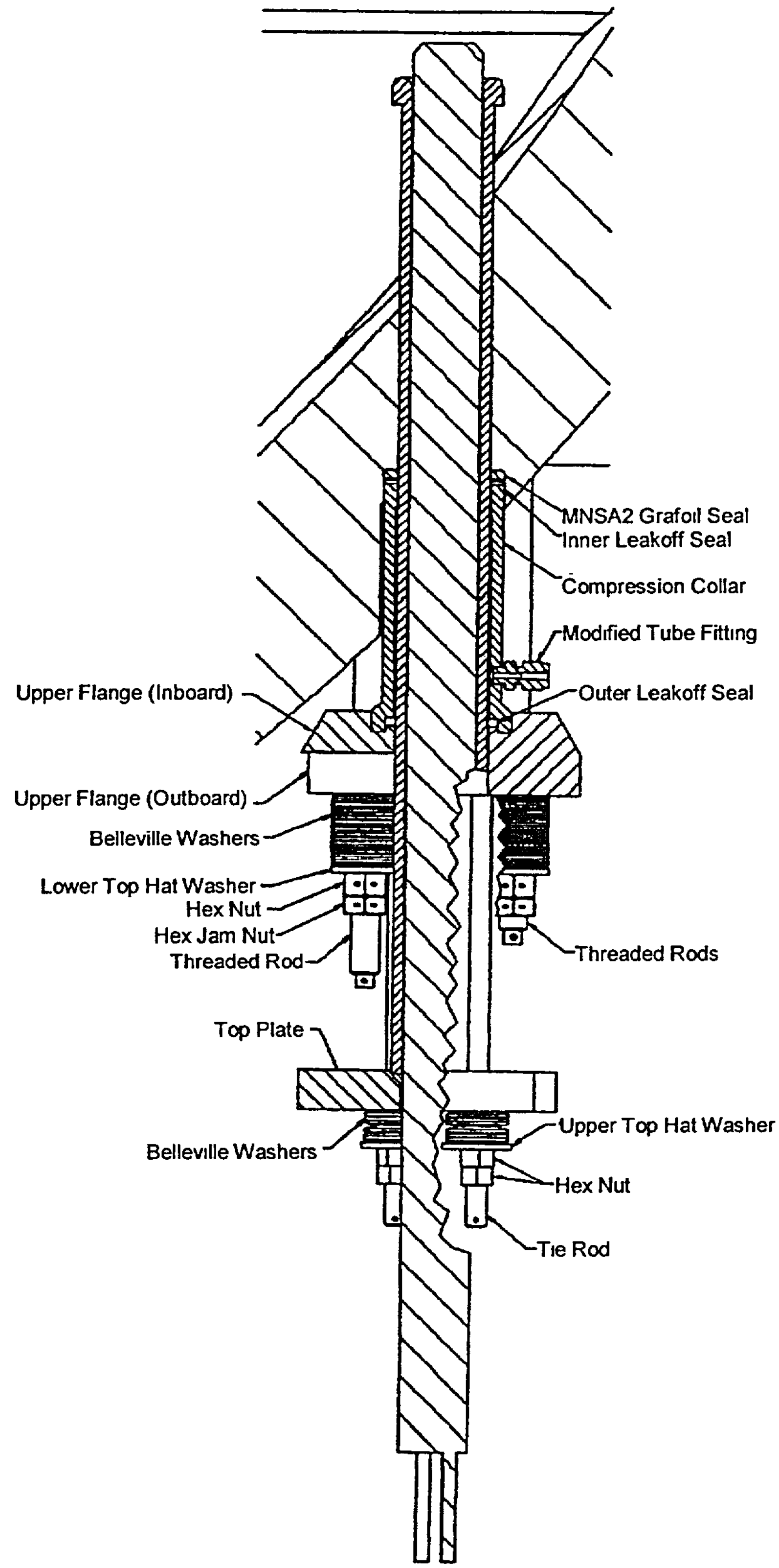
- The non-Code portions of the MNSA-2 that perform a safety-related function are provided under a program meeting 10CFR50 Appendix B.

- After installation, the MNSA-2 will be pressure tested and inspected (uninsulated) for leakage to ensure quality of installation and leak tightness.

- The information provided in this relief request supports the use of the MNSA-2 for up to 2 (two year) operating cycles.

Therefore, we request authorization to perform the requested alternative to the Code requirement pursuant to 10CFR50.55a(a)(3)(i).

FIGURE 1
Heater Sleeve MNSA-2



Appendix 1

CORROSION ISSUES WITH MNSA-2 MATERIALS

The appendix summarizes corrosion issues associated with the application of MNSA-2 for small diameter Alloy 600 nozzle repair. The evaluation is a qualitative assessment of the susceptibility of the MNSA-2 fasteners and seals to known corrosion mechanisms that would be the dominant concerns for a MNSA - 2 used to repair a leaking pressurizer heater sleeve. After installation of a MNSA-2 to prevent leakage from a heater nozzle, it will be necessary to evaluate all current and any new data, including stress and fatigue calculations, before the first refueling outage or examination. The materials of interest are the carbon or low-alloy steel used in the components with defective nozzles, the stainless steels used for the MNSA-2, the fastener material used to attach the MNSA-2 to the component, and the Alloy 600 nozzles that may be repaired.

Corrosion of Carbon/Low Alloy Steel. If a repaired nozzle has a through-wall crack, the crevice between the Alloy 600 sleeve and the pressurizer will, under worst case conditions fill with aerated borated water. The crevice environment will be a stagnant solution that cannot be replenished except during shutdowns when the pressurizer is drained and the RCS is depressurized. Thus, the concentration of boric acid will not exceed that of primary coolant at the beginning of a fuel cycle. The corrosion of carbon and low alloy steels has been evaluated (reference 2, section 4). The data show that the highest corrosion rates occur at the interface between hot wetted surfaces and dry surfaces where evaporation will increase the concentration of boric acid. The corrosion rate is maximized in the range of 200 degrees F to 400 degrees F and it diminishes on either side of this band (reference 2, page 4-11). The wetting and drying mechanisms required to concentrate boric acid in the crevice area are not expected to occur during normal operation of the plant at temperatures above 400 degrees F. The corrosion rate data suggest rates of corrosion in the .01 to .001 inch per year rate (reference 2 section 4.9). It would take on the order of tens of years at the expected corrosion rates in the expected conditions to exceed the allowable material loss. This supports the conclusion that carbon and low alloy steel corrosion is not a concern for the duration of a two year refueling cycle (i.e., between inspection periods).

Stress Corrosion Cracking (SCC) of Carbon and Low Alloy Steels. The repaired heater sleeves will have cracks in the Alloy 600 nozzles or the partial penetration weld metals that will remain in place after the repair is installed. Stress corrosion cracking of low alloy steels takes the form of fine cracks possibly without the appearance of surface degradation typical of boric acid corrosion. Stress corrosion cracking is considered to be environmentally induced stable crack growth under static tensile stress. Industry data (reference 2, section 3.3.5 and reference 1) supports the conclusion that stress corrosion cracking is only a concern in the case of highly loaded components, such as those on steam generator manways in the presence of a sulfur based contaminant. Highly stressed components would have yield strengths in the 100 to 200 ksi range. The pressurizer vessel material is SA-533 grade B class 1 carbon steel with a typical yield strength of approximately 50 ksi. Therefore, stress corrosion cracking of the pressurizer material exposed to borated reactor coolant is not a concern.

Stress Corrosion Cracking (SCC) of the MNSA-2 Fasteners. The fasteners attaching the MNSA-2 components are SA-453 grade 660 (A286 stainless steel). The fasteners are high strength material. Industry data (reference 2, section 4.2) have shown this material is only susceptible to SCC in the presence of boric acid when highly stressed (100 to 200 ksi). Hot worked bolts are more susceptible to SCC than bolts machined from heat treated stock (reference 3) because the deformation is greater in the center. The MNSA-2 fasteners are machined from bar stock and thus will be less susceptible to SCC. The MNSA-2 fasteners are located on the exterior of pressurizer where the material will not be exposed to primary coolant. SCC is not a concern in the absence of an aggressive environment.

In the unlikely event that the live loaded primary seal developed a leak, the secondary seals divert any leakage away from the fasteners and prevent exposure of borated water and steam. If the leakage was not channeled away from the fasteners, a wetting and drying condition could be expected on the exterior of the pressurizer. This may expose the fasteners to concentrated boric acid crystals. However, industry data (reference 2 section 4.2) indicated that the SA-453 material is only susceptible to SCC in a highly stressed condition. The fastener material is not highly stressed in normal service. High stresses of the material would only occur during faulted conditions associated with nuclear power plant reactor coolant system. Leakage is a condition that will require repair and will be observable by visual examination. Therefore, this condition would not be expected to exist for more that one 24 month fuel cycle. Thus, SCC of the MNSA-2 fasteners is not a concern.

Corrosion Near the Component OD Surface. If the MNSA-2 primary seal leaks, leakage is funneled into the annular area between the stainless steel MNSA-2 collar and the outside diameter (OD) of the stainless steel heater sleeve. The secondary seals should prevent surface exposure of concentrated boric acid. The installation of a MNSA-2 does not require any welding of the nozzle. There will not be any residual stresses such as those that occur due to performing a welded joint. The exterior temperature and pressure of the pressurizer is lower. Since PWSCC is a thermally activated process and the area is not highly stressed, the time to initiate and propagate cracks is much longer compared to the rates of propagation associated with conditions that activate PWSCC. The Grafoil seal material has low leachable chlorides thus significant pitting is not expected to occur. A minor amount of carbon low alloy steel corrosion may occur if the primary seal has failed. Leakage past the secondary seals or through the tell tale by evaporation of borated water trapped in the annular area could expose the outside surface of the pressurizer to borated water crystals even though the crystals would tend to drop away from the bottom shell of the pressurizer. This is not a concern because evaporation would tend to concentrate boric acid in the annular area and the fact that evaporation has occurred will reduce the temperature and pressure such that activation conditions for PWSCC will not be present and the small volume of boric acid transferred in this manner will limit the expected borated water corrosion rates. External leakage is a condition that will require repair and will be observable by visual examination. Therefore, this condition would not be expected to exist for more that one 24 month fuel cycle. Therefore, corrosion near the OD surface is not a concern.

Galvanic Corrosion. Galvanic corrosion occurs as a result of the differences in electrochemical potential between the different parts of a cell in a conductive solution. The material with the highest electrochemical potential corrodes preferentially. The grafoil seal and the carbon or low alloy metals would degrade as a result of this corrosion mechanism. The grafoil seal is very resistant to borated water corrosion and chemical attack. With respect to low alloy metals, galvanic corrosion is more of a concern in welded applications due to high residual stresses. The installation of a MNSA-2 does not require any welding reducing the residual stresses that would be present. Available data (reference 2, section 3.3.1) has not identified galvanic corrosion as a concern for this type of application. In the absence of leakage past the Grafoil seal, the boric acid solution in the annulus region, below the seal, will become stagnant and will not allow replenishment of oxygen thereby limiting the corrosion potential. Visual examinations will be conducted and would identify leakage that resulted from galvanic corrosion. Therefore, galvanic corrosion is not a concern for the MNSA-2 repair.

Outside Diameter (OD) Initiated Stress Corrosion Cracking of the Alloy 600 Nozzles. The installation of the MNSA-2 requires machining a counter bore area around the OD of the sleeve. The machining is a cold working process that will not increase the residual stress in comparison to residual stress in a welded joint. The additional machining required during installation of a MNSA-2 clamp is not expected to have an adverse effect on the SCC susceptibility of the sleeves for the following reasons:

1. The sleeve OD surfaces were previously machined during original fabrication. The additional machining is the same cold working process and will not create residual stresses different from those already present.

2. The sleeves will not be welded eliminating the residual stresses associated with the partial penetration weld at the pressurizer inside diameter (ID).
3. The temperature at the OD is lower than the ID. Since PWSCC is a thermally activated process, the time to initiate and propagate cracks will be longer.

SCC of 17-7 PH Stainless Steel. 17-7 PH stainless steel is used in the inner and outer Belleville washers in the MNSA-2. 17-7PH materials are very close in composition to 17-4PH materials evaluated in Reference 2. The materials of the MNSA are SA-453 Grade 660 (A-286) and the sleeve is type 304 stainless. Available data on stainless steels (reference 2, section 4.2 EPRI test-1), indicates that these materials are unaffected by concentrated aerated boric acid. SCC is not a concern for these stainless steel components.

Gross Failure of the Inner Seal. If the inner seal fails, the crevice between the MNSA-2 compression collar and the compression collar will receive primary coolant. These are not pressure boundary components, so it is assumed that primary coolant will escape into the containment environment. There is no accident mitigation or safety equipment that is located under the pressurizer such that it could be immediately damaged by escaping high pressure primary coolant. The amount of flow out of the reactor coolant system would be limited by the size of the annular area between the heater sleeve and the pressurizer. External leakage is a condition that will require repair. Small leaks will be observable by visual examination. Larger leaks, those greater than 1 gpm, will be detected by increasing sump level or other means. Review of industry events (section 2 reference 2) has not identified any cases of major loss of primary system integrity due to gasket leakage. Therefore, this condition, if not detected immediately and resolved, would not be expected to exist for more that one 24 month fuel cycle.

Summary

Based on the above evaluation of potential corrosion effects, it is concluded that there are no significant corrosion issues associated with the application of MNSA-2 to pressurizer heater sleeves. The data indicates that corrosion of the sleeve hole will also be acceptable for at least the requested two cycle period of use.

References

1. WOG Report CE-NPSD-690-P; subject: "Evaluation of Pressurizer Penetrations and Evaluation of Corrosion After Unidentified Leakage Develops" dated January 1992.

2. EPRI Technical Report 1000975; subject Boric Acid Corrosion Guidebook Revision 1, Managing Boric Acid Corrosion Issues at PWR Power Stations
3. Structure and Properties of Engineering Materials by Robert M. Brick, Alan W. Pense, and Robert B. Gordon fourth edition.

Enclosure 8

Letter from Michael A. Krups to US Nuclear Regulatory Commission

Entergy

Entergy Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213-8298
Tel 601 368 5758

Michael A. Krupa
Director
Nuclear Safety & Licensing

CNRO-2002-00010

March 1, 2002

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 205550001

Subject: Entergy Operations, Inc.
Use of Mechanical Nozzle Seal Assemblies

Waterford Steam Electric Station – Unit 3
Docket No. 50-382
License No. NPF-38

Ladies and Gentlemen:

Pursuant to 1 0CFR50.55a(a)(3)(i), Entergy Operations, Inc. (Entergy) requests NRC staff authorization to use the new design of the Mechanical Nozzle Seal Assembly (MNSA-2) in temporary applications as documented in Request for Alternative W3-R&R-002, Rev. 0 (see Attachment I). Entergy intends to utilize MNSA-2s on various locations in the reactor coolant system (RCS) that are exhibiting leakage due to Primary Water Stress Corrosion Cracking (PWSCC) at the Waterford Steam Electric Station – Unit 3 (Waterford 3). The use ***of the MNSA-2 covered by this request will be limited to two (2) operating cycles.*** Entergy is continuing to evaluate the use of the MNSA-2 for permanent application and may seek such relief in the future.

Entergy believes use of MNSA-2s for restoring structural integrity and leak tightness to the RCS provides an acceptable level of safety and quality. The NRC staff previously authorized temporary use of the original MNSA design at Southern California Edison's San Onofre Nuclear Generating Station[1], at Waterford 3[2], and most recently at Arizona Public Service Company's Palo Verde Nuclear Generating Station[3].

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[1] NRC Letter from Mr. W. H. Bateman to Mr. H. B. Ray, "Use of Mechanical Nozzle Seal Assembly for the San Onofre Nuclear Generating Station, Units 2 and 3 (TAC Nos M99558 and M99559)," dated February 17, 1998

[2] NRC Letter from Mr. G. F. Dick to Mr. C. M. Dugger, "Use of the Mechanical Nozzle Seal Assemblies at Waterford Steam Electric Station, Unit 3 (TAC No. MA4952)," dated March 25, 1999

[3] NRC Letter from Mr. S. Dembek to Mr. G. R. Overbeck, "Palo Verde Nuclear Generating Station Units 1, 2, and 3 – Request for Code Alternative for the Use of Mechanical Nozzle Seal Assemblies – Relief Request No. 17 (TAC Nos MB1618, MB1619, and MB1620)"

A001

During the upcoming refueling outage at Water-ford 3, currently scheduled to begin in March 2002, Entergy plans to inspect small-bore nozzles on the pressurizer; specifically, two (2) lower level instrument nozzles, one (1) shell side temperature nozzle, and 29 heater sleeves for a total of 32 nozzles. Upon evidence of a leak, Entergy intends to install a MNSA-2 to restore structural integrity and leak tightness.

Currently, Entergy has no evidence of leaking pressurizer nozzles; however, we are submitting this request in order to proactively prepare for possible leaks that may be detected while performing inspections during the outage. Therefore, Entergy requests that the NRC staff approve W3-R&R-002, Rev. 0 by April 2, 2002, in order to support these inspection activities. ***Following NRC Staff approval, Entergy will incorporate this alternative into the Water-ford 3 Inservice Inspection (ISI) Plan.***

To assist the Staff with its review of W3-R&R-002, Entergy is also providing supporting information in Attachments 3 through 6. As supporting documents, these attachments are not considered part of W3-R&R-002 and will not be incorporated into the Waterford 3 ISI Plan. Attachment 3 contains a "road map" that identifies the location of information associated with the request. Attachments 4, 5, and 6 contain engineering reports regarding testing for the MNSA-2 design.

Entergy considers the information contained in Attachments 4, 5, and 6 to be proprietary and confidential pursuant to 10 CFR 2.790(a)(4) and 10 CFR 9.17(a)(4). As such, Entergy requests this information be withheld from public disclosure. The affidavit supporting this request is provided in Attachment 2. Because the vast majority of the information contained in the attachments is considered proprietary, Entergy considers it impractical to provide nonproprietary versions.

Entergy will submit under a separate cover letter the revised stress report, Westinghouse Design Report No. DAR-CI-02-1, "Addendum to CENC-1244 Analytical Report for Water-ford Unit 3 Pressurizer," which provides methodology used to determine acceptable application of the MNSA-2 in conformance with ASME Code requirements. In addition, Entergy will also include responses to issues raised by the Staff at the January 31, 2002 meeting at which Entergy discussed the MNSA-2 application. Entergy plans to submit this report on or before March 6, 2002.

This letter contains two new commitments as denoted above in bold, italicized text.

Should you have any questions regarding this request, please contact Guy Davant of my staff at (601) 368-5756.

Very truly yours,

M. A. Krupa

MAK/GHD/baa

Attachments:

1. Request for Alternative W3-R&R-002, Rev. 0
2. Affidavit for Withholding Information from Public Disclosure
3. List of Supporting Documents
4. Westinghouse Test Report No. TR-ME-02-2, Rev. 0, "Test Report for Hydrostatic Testing of the Entergy Mechanical Nozzle Seal Assembly (MNSA2)"
5. Westinghouse Test Report No. TR-CI-02-2, Rev. 0, "Seismic Qualification Testing of the Entergy (WSES-3, ANO Units 1 & 2) MNSA-2 Clamps for Pressurizer Heaters and Instrument Nozzles"
6. Westinghouse Test Report No. TR-CI-02-03, Rev. 0, "Test Report for Entergy MNSA-2 Clamps Thermal Cycle Test"

cc: Mr. W. R. Campbell (ECH) (w/o)
Mr. J. K. Thayer (ECH) (w/o)
Mr. J. E. Venable (W3) (w/o)

Mr. T. R. Farnholtz, NRC Senior Resident Inspector (W3) (w/l)
Mr. N. Kalyanam, NRC Project Manager (W3)
Mr. E. W. Merschoff, NRC Region IV Regional Administrator (w/l)

ATTACHMENT 1

REQUEST FOR ALTERNATIVE

W3-R&R-002, Rev. 0

REQUEST FOR ALTERNATIVE
W3-R&R-002, Rev. 0

I. Components

Components/ Numbers:	Pressurizer lower level instrument nozzles / (2) Pressurizer shell side temperature nozzle / (1) Pressurizer heater sleeves / (29)
Code Class:	ASME Section III, Class 1
References:	1) ASME Section III, 1989 Edition 2) ASME Section III, 197 1 Edition through and including Summer 1971 Addenda 3) Westinghouse Test Report No. TR-ME-02-2, Rev. 0, "Test Report for Hydrostatic Testing of the Entergy Mechanical Nozzle Seal Assembly (MNSA2)," dated 2/2 1/02 4) Westinghouse Test Report No. TR-(X-02-2, Rev. 0, "Seismic Qualification Testing of the Entergy (WSES-3, AN0 Units 1 & 2) MNSA-2 Clamps for Pressurizer Heaters and Instrument Nozzles," dated 1/3 1/02 5) Westinghouse Test Report No. TR-CI-02-03, Rev. 00, "Test Report for Entergy Mechanical Nozzle Seal Assembly (MNSA2) Thermal Cycle Test," dated 2/22/02 6) Westinghouse Design Report No. DAR-CI-02- 1, "Addendum to CENC-1244 Analytical Report for Waterford Unit 3 Pressurizer," dated 2/1 9/02
Unit / Inspection Interval Applicability:	Waterford 3 second (2nd) 1 O-year interval

II. Code Requirements

ASME Section XI, IWA-4170 requires repairs and installation of replacements to be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. The affected pressurizer instrument nozzles and heater sleeves were designed and constructed to the rules of ASME Section III, Subsection NH, 1971 Edition, through and including the Summer 197 1 Addenda. Rules for replacing ASME Section III, Class 1 welded nozzle or heater sleeve integrity with mechanical clamping devices are not clearly defined by ASME Section III.

III. Proposed Alternative

Pursuant to 10CFR50.55a(a)(3)(i), Entergy Operations, Inc. (Entergy) requests NRC authorization to use the improved design of the Mechanical Nozzle Seal Assembly, designated MNSA-2, in applications at those nozzle locations listed in Section I, Components, above.

Entergy makes this request in order to repair leaks attributed to Primary Water Stress Corrosion Cracking (PWSCC) that may be detected while performing inspections during refueling outages.

The typical repair of nozzles or heater sleeves of this type uses a half-nozzle replacement with external weld repair. These repairs would extend reactor coolant system (RCS) drain-down activities or require de-fueled conditions and significantly increase worker radiation exposure to perform extensive field machining and temper bead welding activities.

As an alternative, Entergy proposes to use the MNSA-2 as a repair to restore nozzle or heater sleeve integrity and prevent leakage for 2 operating cycles.

IV. Basis for Proposed Alternative

A. Background

The pressurizer, including the nozzle and heater sleeve penetration assemblies, were designed by Combustion Engineering. The nozzles and heater sleeves are described below:

- Pressurizer lower level instrument nozzles (2)

  The pressurizer instrument nozzles are fabricated from Ni-Cr-Fe, SB-166 material (Inconel 600) with SA- 182, F-3 16 stainless steel ¾-inch diameter socket weld safe ends, The nozzles are welded to the inside of the pressurizer. The lower level instrument nozzles contain a 3/1 6-inch diameter orifice that serves as the system class break from the Class 1 system to the downstream Class 2 system. The nozzle inside bore is approximately 0.614 inch, and the outside diameter is approximately 1.062 inches. The total length of the nozzle, including the safe end, is approximately 12 5/8 inches. The J-weld uses INCO-182 filler material.

- Pressurizer side shell temperature nozzle (1)

  The temperature element nozzle is fabricated from Ni-Cr-Fe, SB- 166 material (Inconel 600) with a SA-182, F-3 16 stainless steel l-inch diameter socket weld safe end.. The nozzle inside bore is approximately 0.815 inch, the outside diameter is approximately 1.3 15 inches, and overall length of the nozzle, including safe end, is approximately 14 1/8 inches. The nozzle is welded to the inside of the pressurizer. The J-weld uses INCO- 182 filler material.

- Pressurizer heater sleeves (29)

  The pressurizer heater sleeves are manufactured from Ni-Cr-Fe, SB- 167 material (Inconel 600). The heater sleeve assemblies are welded to the internal cladding of the vessel lower head and the heater elements are welded to the lower end of the sleeves. The heater elements are internally supported for seismic loading and vibration by two heater support plates. The outside diameter of the sleeve is approximately 1.660 inches, and the inside bore is approximately 1.273 inches. The length of the sleeves varies from approximately 14 3/8 inches long to approximately 18 3/8 inches long, depending on the location on the bottom head. The upper end of the heater sleeve is provided with a short oversize segment to serve as an anti-ejection device should the sleeve to vessel weld fail completely.

- Pressurizer vessel

  The pressurizer is a low alloy steel vessel with the shell and top head internally clad with 304 austenitic stainless steel and the bottom head with a Ni-Cr-Fe cladding.

The Ni-Cr-Fe heat affected zone of the J-weld has proven to be susceptible to PWSCC. Numerous instances of nozzle cracking have been identified in the industry in recent years. Studies performed by the Combustion Engineering (CE) Owner's Group (Report CE-NPSD-690-P) have found that the cracking growth is predominantly axial. The dominant conditions that promote axial growth rather than circumferential growth is high circumferential stress (hoop stress) compared to the axial stress. The hoop stress is a residual stress caused by weld shrinkage that diminishes quickly as the distance from the J-weld increases. The susceptibility to cracking is based on several factors that deal with material, stress, and environment.

Inspections required by ASME Section XI, IWB-2500 for Examination Category B-P are performed during each refueling outage. Additionally, the inspections recommended by the CE Owner's Group have been performed.

B. MNSA-2 Application, Description, and Design

1. Overview

The MNSA-2 is a mechanical device designed to replace the function of partial penetration J-groove welds that attach Alloy 600 nozzles or heater sleeves to the pressurizer. MNSA-2 provides a seal against leakage and positively captures the nozzle preventing ejection in the unlikely event of complete 360-degree weld failure. Figure 1 shows a representative drawing of the MNSA-2 for heater sleeve installation, and Figure 2 shows a representative drawing of the MNSA-2 for side shell temperature nozzle installation. (The lower level nozzle design is shown in the Addendum to the Design Report [Reference 6].)

To install the MNSA-2, four holes are drilled and tapped (½" diameter x 1 ½" deep) equally spaced around the leaking nozzle or sleeve. A counter-bore (approximately ¼" wide x ¾" deep) is also machined into the surface of the vessel perpendicular to and around the leaking nozzle or sleeve. Four threaded rod studs are threaded into the pressurizer, a split Grafoil primary seal is installed in the bottom of the counter-bore, and a split compression collar is placed over the nozzle or sleeve to compress the Grafoil seal. The seal assembly is compressively loaded via the compression collar and the inboard and outboard flange assembly, which is in the annulus region. Hex nuts and Belleville spring washers are used to live load the Grafoil seal to accommodate small changes in load on the seal due to differential expansion or minute relaxation of the seal over time to prevent seal leakage.

To prevent nozzle or heater sleeve ejection in the unlikely event of a complete nozzle or sleeve weld failure, an anti-ejection clamp is also installed and secured in place via the tie rods, Belleville spring washers, and hex nuts. The anti-ejection clamp acts as a restraint only if the nozzle-to-RCS weld completely fails.

More specific details of the MNSA-2 design are provided in Section B.2, below.

2. MNSA-2 Design

The NRC previously authorized use of the original MNSA design at Southern California Edison's San Onofre Nuclear Generating Station, at Waterford 3, and at Arizona Public Service Company's Palo Verde Nuclear Generating Station.

The original MNSA and MNSA-2 use the same materials of construction and the same seal material. They are attached in the same fashion, and the seal is loaded by tensioning bolts or studs.

The MNSA-2 design differs from the original MNSA design in three ways:

- The counter-bore provision that contains the seal
- The manner in which the seal is live-loaded
- The means for diverting leakage, should it occur

Each is discussed in detail below.

a) Counter-Bore Provision

MNSA-2 uses nuclear grade Grafoil as the sealing material. In all cases, regardless of the angle of the surface of the pressurizer relative to the nozzle, a counter-bore is machined perpendicular to the nozzle to receive and contain the seal. The bottom of the counter-bore is perpendicular to the axis of the nozzle, so the angle of the surface of the pressurizer does not affect the leak tightness of the design. When the MNSA-2 seal is compressed, no side loads are introduced, so shoulder bolts used on the original MNSA are not required. The seal designs are simpler than the original MNSA because they involve no variable angles. Therefore, customizing MNSA components for particular slope angles, for other than bolt lengths, is not required.

b) Seal Live-Loading

MNSA-2 uses a live-loaded seal that can accommodate small changes in load on the seal due to differential expansion. The live load provision, provided via Belleville washers, also accommodates minute relaxation of the seal over time to prevent leakage. Finally, it allows for re-tightening of the studs and reloading the seal at some point in the future without disassembly, whereas the original MNSA would require a new seal and complete teardown and re-assembly to re-energize a seal. Figures 1 and 2 show the use of Belleville spring washers.

c) Leak-Off Diversion

Leakage control in the MNSA-2 design is accomplished by using a compression collar which includes a collection area (similar to a "lantern ring") positioned immediately outboard of the primary seal, as shown in Figure 1. The compression collar has an additional Grafoil seal at the top that is lightly loaded. The seal blocks leakage from passing up along the outside of the compression collar where it could reach the threaded rods. The path of least resistance is out through the annulus between the compression collar and the nozzle, tending to divert any leakage away from the fasteners and the vessel. The presence of the collection area does not impair the primary seal in any way.

In the review of the original MNSA design, the NRC evaluated potential corrosion effects of boric acid on the MNSA and associated RCS components. The evaluation considered:

- Corrosion of the low alloy material with a MNSA installed was determined to be acceptable
- Boric acid corrosion of the materials of construction for the MNSA was determined to be acceptable based on CE Owner's Group corrosion testing
- There is no history of galvanic corrosion problems in similar applications with Grafoil contacting low alloy steel
- Potential for SCC failures of the A286 bolts was found to be acceptable

There are no changes from the original MNSA to MNSA-2 that adversely impact the four conclusions listed above. With regard to the A-286 bolts, the NRC evaluation concluded that the bolts could be exposed to boric acid deposits or slurries, if the MNSA leaks. This evaluation was appropriate because the design did not include provisions for capturing or diverting seal leakage away from bolting materials. Regardless, at the stress levels that exist in the bolts, including a stress concentration factor of four, the bolts would function satisfactorily. In contrast to the original MNSA, the MNSA-2 design includes specific provisions to divert potential seal leakage away from the low alloy steel vessel and the bolting as described below.

The sealing qualities of MNSA-2 are enhanced beyond that of the original MNSA by virtue of the controlled geometry (counter-bore), and by maintaining a live load on the seal. The counter-bore design has been used routinely in hundreds of similar applications for sealing fixed in-core detectors to flanges on the reactor head in CE units. A variety of other repairs and permanent flange upgrades have been installed on both CE and Westinghouse units using both static and live-loaded Grafoil seal technology. Therefore, the possibility of a leak past the primary seal is very small. Nevertheless, in the unlikely event of such a leak, MNSA-2 is designed to limit exposure of the SA-453 (A-286) bolting material and the carbon steel vessel by providing a leak-off path.

d) Installation

The MNSA-2 installation process is non-intrusive on the existing heater sleeve or instrument nozzle pressure boundary, and it does not require draining of the pressurizer to install. In addition to the counter-bore, a small groove is machined in the end of instrument nozzles to receive the anti-ejection plate as shown on Figure 2. The tooling is designed to machine the counter-bore and groove without disconnecting the pressure boundary heater element, instrument tubing or thermowell.

Torquing the MNSA threaded rods into the pressurizer will be performed at temperatures above RT_{NDT} (30 °F) to ensure the bolting stress does not create a potential for brittle failure.

3. MNSA-2 Materials

The MNSA-2 assembly is fabricated from the same materials as the original MNSA, though with different application of some of the components. A detailed assessment of the MNSA-2 metallic components as related to general corrosion, stress corrosion cracking of nozzles and fasteners, galvanic effects, crevice corrosion, and surface pitting of the constituent components is contained in Appendix 1 of this relief request. There are no potential corrosion problems associated with the application of the MNSA-2 to Alloy 600 small diameter nozzles and heater sleeves.

The stainless steel portions of the MNSA-2 performing an RCS pressure boundary function are manufactured in accordance with material specifications provided in ASME Section III, Subsection NB and Appendix I. Additionally, the material meets the requirements contained in NB-2000 including examination and testing. Materials are supplied to the provisions of ASME Section III, NCA-3800 by suppliers maintaining a valid Quality System Certificate or a Certificate of Authorization with the scope of Material Supply. Metallic pressure boundary material is certified in accordance with ASME Section III, NCA-3800.

The primary Grafoil seal material is Grade GTJ (used in nuclear applications) composed of 99.5% graphite, with the remaining 0.5% made up of ash, halides, and sulfur. The Grafoil seal itself is chemically resistant to attack from organic and inorganic fluids, and is very resistant to borated water. Similar Grafoil material is used as valve packing in valves installed in the RCS with acceptable results. The Grafoil material is provided under the provisions of a Quality Assurance Program meeting 10CFR50 Appendix B that has been approved by Entergy. Material testing and certification is provided with the material to verify compliance with the engineered features that are required to ensure functionality and compatibility with the pressure boundary materials and environment.

In summary, there are no potential corrosion or material stress issues associated with applying the MNSA-2 to the pressurizer heater sleeves or nozzles.

4. MNSA-2 Structural Evaluation

The component parts of the MNSA-2 for heater sleeve, side shell, and lower level nozzle installation are analyzed, designed, and manufactured in accordance with ASME Section III, Subsection NB, 1989 Edition, which is approved in 10 CFR 50.55a. The Waterford 3 original Construction Code for the pressurizer is ASME Section III, 197 1 Edition, through and including the Summer 197 1 Addenda. As required by ASME Section XI, an amendment to the Waterford 3 Pressurizer Stress Report CENC- 1244 [Ref. 6] was completed and includes a reconciliation (see Attachment D of Reference 6) for use of the 1989 Edition of ASME Section III as it applies to the MNSA-2 and its interface with the pressurizer.

The analysis for the MNSA-2 components addressed:

- Stresses not to exceed the allowables as stated in the Code.
- Fatigue to demonstrate that the Code-prescribed cumulative usage factor of 1 .O is not exceeded (NB-3222.4) for any component

The stress analysis considered the loads transmitted to the components of the MNSA-2 due to installation pre-load, normal and upset loads at pressure and temperature, and impact loads due to the ejection of the heater sleeve or nozzle in the unlikely event of a complete failure of the J-weld. The results of the stress analysis demonstrate that the applied stresses on each load-bearing component (tie rods, threaded rods, and top plate) are below the applicable Code allowables, thereby providing assurance of structural integrity for the MNSA-2.

Fatigue evaluations of the MNSA-2 clamp components considered a forty-year design life. The calculated fatigue usage factors in Reference 6 are less than 1 .O for MNSA-2 components. The primary component of the usage factors is the stress range between heat-up and cooldown conditions. However, for two cycles of operation, the expected number of heat-up and cooldown cycles is substantially less than those accounted for in the stress analysis for a 40-year design life.

5. Pressurizer Modification and Structural Evaluation

The MNSA-2 is attached to the pressurizer with SA-453 Grade 660 threaded rods and hex nuts. To accommodate the threaded rods, four holes are drilled and tapped into the pressurizer in a circular pattern around the nozzle. To provide a seating surface for the Grafoil seal, a counter-bore is machined into the pressurizer extending out approximately ¼" from the existing nozzle bore and to a maximum depth of ¾". The addition of the holes in the pressurizer was analyzed and documented in an attachment to the addendum to Stress Report CENC-1244 [Ref. 6] for the heater sleeve, side shell temperature nozzle, and lower level instrument nozzle locations. The analysis is performed to the requirements of ASME Section III, 1971 Edition through and including the Summer 1971 Addenda. The analysis addresses:

- Stresses not to exceed the allowables as stated in the Code.
- Fatigue to demonstrate that the Code prescribed cumulative usage factor of 1 .O is not exceeded (NH-3222.4) at any location

- Adequate reinforcement in the wall of the pressurizer for the tapped holes and counter-bore exists (NB-3332.1 and m-3332.2)

The stress analysis considered all loads evaluated in the original design stress report, including all pressure and temperature transients, the differential thermal expansion loads due to the threaded rods in the tapped holes, compression collar loads, and the loads on the existing J-weld at operating and during shutdown conditions. The applied stresses and stress ranges were evaluated at the counter-bore region and at the tapped holes for compliance with Code allowables. The applied stresses on the pressurizer were modified by the appropriate geometry factors for non-radial effects (where applicable) and by additional factors to take into account stress interaction between the tapped holes and the counter-bore as determined by finite element analysis (FEA). The results of the stress analysis, considering the tapped holes and counter-bore in the pressurizer shell, demonstrate applied stresses are below ASME Code allowables and provide assurance of vessel structural integrity.

Fatigue evaluations of the pressurizer shell in the vicinity of the tapped holes and counter-bores considered a forty-year design life. The calculated fatigue usage factors in Reference 6 are less than 1.0 for in the vicinity of the tapped holes and counterbores for any location subject to MNSA-2 installation. The primary component of the usage factors is the stress range between heat-up and cooldown conditions. However, for two cycles of operation, the expected number of heat-up and cooldown cycles is substantially less than those accounted for in the stress analysis for a 40-year design life.

The area reinforcement calculations performed in the original design stress report in accordance with ASME Code Section III NB-3332.1 and 3332.2 were updated to evaluate the removal of pressurizer metal area by machining the tapped holes and counter-bores. The results of the analysis in Reference 6 showed that for each pressurizer nozzle or heater sleeve location evaluated for possible MNSA-2 installation, the area available for reinforcement is greater than the area required as a result of metal removal.

C. MNSA-2 Design Requirements

In accordance with ASME Section XI, IWA-4170, replacements shall meet the requirements of the Owner's Design Specifications and the original Construction Code. Alternatively, replacements may meet later editions of the original Construction Code provided:

- The requirements affecting the design, fabrication, and examination of the item to be used for replacement are reconciled with the Owner's Specification through the Stress Analysis Report, Design Report, or other suitable method that demonstrates the item is satisfactory for the specified design and operating conditions.
- Mechanical interfaces, fits, and tolerances that provide satisfactory performance are compatible with the system and component requirements.
- Materials are compatible with installation and system requirements.

ASME Section III NB-3200 rules are followed for designing and manufacturing the MNSA-2. Specifically, the joints will 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.

(3) The joint must either be designed in accordance with the rules of ASME 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 topics are discussed below.

1. Joint Integrity

In addition to the prototype testing discussed below, the MNSA-2 is analyzed to meet the requirements of NB-3200. The MNSA-2 is designed as an ASME Section III, Class 1, safety-related primary pressure boundary in accordance with the rules of NB-3200 to prevent joint separation under service loads. An amendment to Pressurizer Stress Report CENC-1244 for Waterford 3 [Ref. 6] demonstrates that stresses under all service conditions do not exceed the Code allowables as stated within Section III and that fatigue limits are not exceeded using the conditions contained in the Design Specification.

2. Maintenance, Removal, and Replacement

Typical for mechanical connections, the MNSA-2 will be accessible for maintenance, removal, and replacement after service. The MNSA-2 is manufactured without welding and is bolted in place, so disassembly is a mechanical evolution that requires de-tensioning the installation bolting.

3. Prototype Testing

The original MNSA design was qualified by a series of tests and analyses. With each specific, new application, a Design Specification and a Design Report were prepared. For MNSA-2 applications on the Waterford 3 pressurizer, a single set of tests was performed for an outer heater sleeve MNSA-2, the most conservative configuration.

In addition to the integrity and functional characteristics demonstrated by design and analysis in accordance with ASME NB-3200, significant prototype testing was performed to demonstrate the functionality, structural integrity, and the sealing capability using conservative, bounding service loadings. Detailed descriptions of the prototype testing procedures and results (References 3, 4, 5) are provided to the NRC Staff as Enclosures to the correspondence that submits this relief request.

The objective of the prototype testing was to use the most conservative penetration based on size and geometry to envelop all pressurizer penetration locations for hydrostatic, thermal cycling, and seismic tests. The heater sleeve on the upper hillside of the pressurizer bottom head was chosen as this bounding penetration. The prototype testing verified leak tightness and structural integrity of the MNSA-2.

Hydrostatic Test:

The heater sleeve fixture was clamped with a MNSA-2 with the heater sleeve filled with demineralized water. The nozzle was not welded to the mounting fixtures. Per Reference 3, the hydrostatic test consisted of pressurizing the seal assembly fixture to 3,250 psig ± 50 psig at ambient temperature conditions and holding the pressure for 10 minutes. Several tests were performed on the pressurizer MNSA-2. No leakage or seal damage was detected after the test.

Thermal Cycling Test:

After completion of the hydrostatic test, the MNSA-2 prototype was subjected to a thermal cycling test (as described in Reference 5) consisting of 3 heatup and cooldown cycles. The test fixture was filled with demineralized water. Each cycle consisted of heating the autoclave from ambient temperature (less than 200°F) to 650°F and raising the pressure to between 2,250 psig and 2,500 psig. The elevated temperature/pressure condition was held for at least 60 minutes, after which the MNSA-2 test fixture was cooled down to ambient conditions (less than 200°F). The remaining thermal cycling tests started from where the original test fixture cooled. No leakage was observed during these tests. At the conclusion of the tests, the MNSA-2 fixture was disassembled, and visual examinations were performed on both the internal surfaces of the flange and on the Grafoil gaskets to look for evidence of any steam wisps, residual fluid deposits, or liquid stains that would indicate a leak. None were detected.

Seismic Testing:

Seismic qualification was performed in accordance with the guidelines in IEEE-344. A test specimen representative of an outer heater sleeve MNSA-2 design for Waterford 3 was attached to an adapter plate and mounted to a shaker table. The heater sleeve test specimen was not welded to the mounting fixtures. The MNSA-2 components were assembled and installed onto the simulated heater sleeve mock-up. The seismic testing consisted of subjecting the MNSA-2 test rig to five operating basis earthquake events and one safe shutdown earthquake event. The mounting fixture permitted pressurization to 3,175 psig ± 50 psig at ambient temperature during the seismic test. This elevated pressure was conservatively used to account for the fact that the seismic testing was performed at ambient temperatures rather than operating temperatures. The test results indicate that no mechanical damage occurred and no leakage was present. Information contained in Reference 4 provides a basis for performing the seismic testing using ambient temperatures and concludes that the test results were applicable to hot conditions.

The test program and test results described in References 3, 4, and 5 have been reviewed and found to adequately represent or bound the conditions for which Entergy proposes to install the MNSA-2 at Waterford 3. The test data along with the analysis provides assurance that the MNSA-2 is capable of performing as the pressure boundary and preventing leakage during all modes of operation and all accident conditions.

The MNSA-2s to be installed at Waterford 3 will be subjected to the conditions described below which are obtained from the Design Specification and form part of the basis for analysis. As evidenced by the prototype test summaries, the prototype test conditions equal or exceed the operating conditions for which the clamps will be exposed.

	Waterford 3 Conditions	MNSA-2 Design
Design Pressure	2500 psia	2500 psia
Design Temperature (Pressuizer)	700°F	700°F
Nominal Operating Pressure	2250 psia	
Normal Temperature (Pressuizer)	653°F	

D. Inservice Testing and Inspection

1. ASME Section XI Preservice

The bolting and tie rods of the MNSA-2 are considered ASME Section XI, Examination Category B-G-2, Item No. B7.50 bolting. As required by IWA-4820, a VT- 1 pre-service inspection will be performed in accordance with IWB-2200.

2. ASME Section XI Pressure Tests

In accordance with ASME Section XI, IWA-47 1 O(c) and the alternatives of Code Case N-4 16, mechanical joints made in the installation of pressure retaining replacements shall be pressure tested. The test will be performed and a VT-2 inspection performed as part of plant re-start and will be conducted at normal operating pressure with the test temperature determined in accordance with the Waterford 3 Pressure and Temperature Limits as stated in the Waterford 3 Technica Specifications.

3. ASME Section XI Inservice Inspection

The VT- 1 inservice inspections required by ASME Section XI for Examination Category B-G-2 are required by "period" over the lo-year interval and would not be performed more frequently than during refueling cycles. The VT-2 inspection required by ASME Section XI for Examination Category B-P is required to be performed prior to plant startup following each refueling outage.

V. Conclusion

10CFR50.55a(a)(3) states:

"Proposed alternatives to the requirements of(c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety, or

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Entergy believes that the proposed alternative provides an acceptable level of quality and safety because:

- The design of the MNSA-2 is in accordance with ASME Section III, 1989 Edition, NB-3200. The analysis includes provisions for fatigue and assurances that stresses do not exceed Code allowables. Additionally, significant prototype testing (seismic, hydrostatic, and thermal cycling) has been completed that demonstrates functionality and leak tightness during conditions of operations that are representative of Waterford 3.

- Modification of the Pressurizer was analyzed in accordance with the original Construction Code (ASME Section III, 1971 Edition through and including the Summer 1971 Addenda). Analysis included fatigue, reinforcement requirements for the tapped holes and counter-bores, and assurance that stresses do not exceed Code allowables.

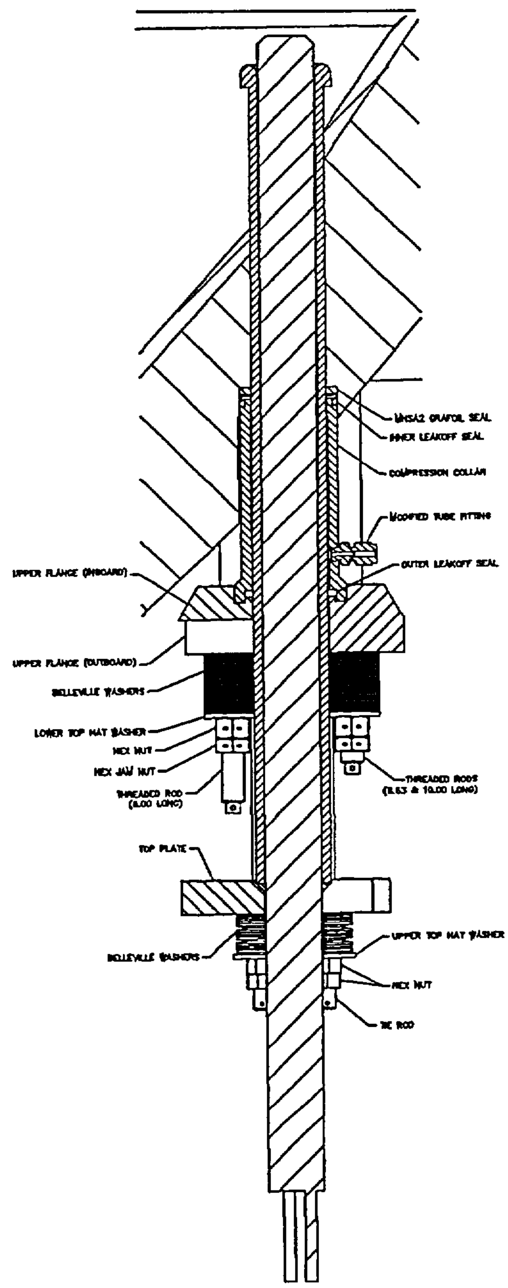
- Methods of analysis, materials, and fabrication meet ASME Section III, Subsection NB. This is comparable to the original methods of analysis, materials and fabrication used for the Pressurizer.

- The non-Code portions of the MNSA-2 that perform a safety-related function are provided under a program meeting 10CFR50 Appendix B.

- After installation, the MNSA-2 will be pressure tested and inspected (uninsulated) for leakage to ensure quality of installation and leak tightness.

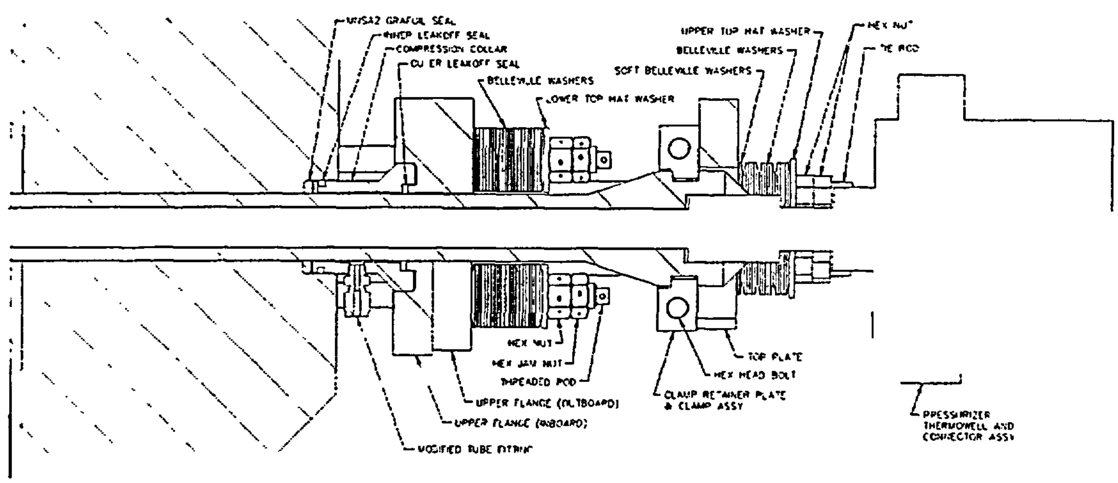
- The request for the alternative is limited to 2 operating cycles.

Therefore, we request authorization to perform the requested alternative to the Code requirement pursuant to 10CFR50.55a(a)(3)(i).



<u>**Heater Sleeve MNSA-2**</u>

FIGURE 1



Side Shell MNSA-2

FIGURE 2

W3-R&R-002, Rev. 0

APPENDIX 1

CORROSION ISSUES WITH MNSA-2 MATERIALS

REQUEST FOR ALTERNATIVE
W3-R&R-002

Appendix 1

CORROSION ISSUES WITH MNSA-2 MATERIALS

This appendix summarizes the several corrosion issues associated with the application of MNSA-2 for small diameter Alloy 600 nozzle repair. The materials of interest are the carbon or low alloy steel used in the components with the defective nozzles, the stainless steels used for the MNSA-2, the fastener material used to attach the MNSA-2 to the component, and the Alloy 600 nozzles that may be repaired.

Corrosion of Carbon/Low Alloy Steel. Assuming a repaired nozzle has a through-wall crack, the crevice between the Alloy 600 nozzle and the pipe/pressurizer will, under worst-case conditions, till with aerated borated water. The crevice environment will be a stagnant solution that cannot be replenished except perhaps during shutdowns when the RCS is drained. Thus, the level of boric acid will not exceed that of the primary coolant at the beginning of a fuel cycle. The corrosion of carbon and low alloy steels in this situation has been previously addressed, most notably by Reference 1, which estimated an overall corrosion rate for these materials using available laboratory corrosion data from tests in aerated and deaerated solution at 100 to over 600°F assuming plants operated for 88% of the time, were in outages for 10% of the time and were in start-up conditions for 2% of the time. Reference 1 analyses estimated, for small diameter Alloy 600 nozzles and heater sleeves in CEOG plants, the amount of material that could be lost by corrosion before ASME Code limits would be exceeded. Corrosion rate data and the bounding allowable material loss calculations were used to estimate repair lifetimes for hot leg pipe nozzles of 76 years, for pressurizer nozzles of 56 years and for heater sleeves of 196 years. Thus, the Reference 1 calculations support a conclusion that carbon and low alloy steel corrosion in the crevice region is not an issue.

Stress Corrosion Cracking of Carbon and Low Alloy Steels. The repaired nozzles will have cracks in the Alloy 600 nozzles or the partial penetration weld metals that will remain in place after the repair is completed. Since residual stresses from the welding will remain, these cracks may continue to propagate through the nozzle/weld metal by a stress corrosion mechanism to the carbon or low alloy steel base metal. Reference 1 indicated that further growth into the base metals by SCC is not likely because the low primary side oxygen levels in PWRs will result in corrosion potentials below the critical cracking potentials for these materials in high temperature water.

Stress Corrosion Cracking of MNSA-2 Fasteners. The fasteners attaching the MNSA-2 to the components are SA-453 grade 660 (A-286 stainless steel) which is a precipitation hardening alloy used in applications where corrosion resistance comparable to 300 series stainless steels but higher strength is required. Laboratory tests and field experience have shown A-286 to be susceptible to SCC in a PWR environment when highly stressed References 2 and 3). Hot headed bolts are more susceptible to SCC than bolts machined from heat-treated bar stock. The MNSA-2 fasteners will be machined from bar stock and thus will be less susceptible to SCC. More importantly, the MNSA-2 fasteners will be external to the RCS and thus not exposed to primary coolant. SCC does not occur in the absence of an aggressive environment. If the primary seal were to leak (unlikely since they will receive a live load during service), the secondary seals divert any leakage away from the fasteners and prevent exposure of borated water and steam. If the leakage is not channeled away from the fasteners, and due to the fasteners being hot, a wetting and drying condition could result in an accumulation of boric acid. Laboratory tests indicate that A-286 is resistant to SCC in highly concentrated boric acid solutions (Reference 4). The Aerospace Structural Metals Handbook indicates A-286 is susceptible to SCC in saturated lithium chloride solutions and that anodic polarization further reduces times to cracking in these solutions. The alloy is also susceptible to cracking in boiling sodium chloride solutions and is also susceptible to intergranular corrosion in strong acid solutions such as nitric- hydrofluoric. In the MNSA-2 application, the A-286 will not experience any environments comparable to these. Thus concern about anodic polarization is not warranted. Leakage is a condition that will require repair and will be obvious by boric acid accumulation. This condition will not persist for more than one fuel cycle (24 months maximum) before the leak will be repaired. Thus, SCC of the A-286 is not a corrosion issue for the MNSA-2 application.

Corrosion Near the Component OD Surface. If the MNSA-2 primary seal leaks, leakage into the crevice formed by the MNSA-2 and the component could wet the stainless steel MNSA-2 and the carbon/low alloy steel component material. The telltale leak off connection may permit the ingress of oxygen into the crevice between the seals resulting in an aerated environment. A more likely scenario is that water/steam escaping via the telltale line will force oxygen from the line and that oxygen in the crevice will be consumed by corrosion of the carbon/low alloy steel. The environment in such a situation will probably be similar to that resulting from primary coolant leakage into CRDM crevices. An expert's panel formed to address the issue of SCC growth in CRDM materials has concluded that the environment in such a crevice will be either hydrogenated superheated steam or normal PWR primary water. Further the panel, on the basis of MULTEQ calculations of the concentration process, concluded that there would not be a significant shift in crevice pH from that of primary water. The telltale will indicate leakage, thus leakage should not persist for more than one cycle. A minor amount (several mils maximum) of carbon/low alloy steel corrosion, as described above, may occur. General corrosion of the SS will be negligible. Since the SS in the crevice region will be in compression, SCC will not occur. The Grafoil seal material has low leachable chlorides (< 50 ppm), and because of leakage via the telltale line, the level of chlorides will not accumulate to the level where significant pitting will occur. Thus, corrosion near the component OD surface is not an issue.

Galvanic Corrosion. Galvanic corrosion occurs as the result of differences in electrochemical potential (ECP) between the different parts of a cell in a conductive solution (electrolyte). In this case, the cell parts are the MNSA-2 materials. The material with the highest electrochemical potential corrodes preferentially. In this case, the carbon or low alloy steel would preferentially corrode. Similar combinations of materials have been used in applications requiring periodic inspections and there has not been a history of corrosion. In tests in simulated reactor coolant, low alloy steel specimens coupled to more noble material (Type 304 SS) did not show a significant galvanic effect. The available data do not indicate that galvanic corrosion will be an issue.

Outside Diameter Initiated Stress Corrosion Cracking of the Alloy 600 Nozzles. The outside diameter of the nozzles will be machined by the machining operation that cuts the counter-bore. Any machining operation (cutting with a single point tool, grinding, reaming, etc) will result in a layer of cold-worked (higher strength) material and a change in surface residual stresses (References 5 and 6). The residual stresses may be tensile or compressive. The layer of cold-work material will be several thousandths of an inch thick. If the part is welded subsequent to the machining, tensile residual stresses will result. Because the cold-worked layer has higher strength than the bulk of the material in the nozzle, the surface residual stresses will be higher than if an annealed material had been welded. The higher stresses could result in early initiation of SCC. However, the additional machining associated with MNSA-2 installation is not expected to have an adverse effect on the SCC susceptibility of the nozzles for the following reasons:

(1) The nozzle OD surfaces were previously machined during original fabrication and the additional machining will not significantly alter residual stresses already present.

(2) The nozzles will not be welded. Thus residual stresses such as associated with the partial penetration weld at the pressurizer ID will not be present and SCC initiation is unlikely.

(3) The temperature near the pressurizer OD, the location of the machining, is lower than at the ID surface. Since the temperature is lower and PWSCC is a thermally activated process, the time to initiate and propagate cracks at the machining location will be significantly longer than the time to initiate the cracks that caused the nozzle to need repair.

SCC of 17-4 PH Stainless Steel. 17-7 PH (not 17-4 PH) stainless steel is used for the inner and outer Belleville washers in the MNSA-2 design. A concern was expressed that the material may be susceptible to SCC when coupled to non 17-7 PH materials based on data in the Aerospace Structural Metals Handbook. A review of drawing E-MNSA-2-228-002 indicates that the washers are in contact only with Type 304 or A-286 stainless steels that are very similar in composition to 17-7 PH. The differences in composition are not sufficient to cause a significant galvanic effect. Further, the washers are normally exposed to the containment environment and only when there is a leak is there any potential for exposure to an aqueous environment, in this case steam. Additionally, the leak-channeling feature of the MNSA-2s should divert leakage away from the Belleville washers. The temperatures of the washers (< 350°F) is sufficiently low that SCC is not a concern nor, at this temperature, is the loss of toughness resulting from the 885°F embrittlement phenomenon an issue.

Gross Failure of the Inner Seal. If a major failure of the inner seal occurs, the crevice between the MNSA-2 compression collar and the Alloy 600 nozzle or the crevice between the pressurizer steel and compression collar will receive primary coolant. Primary coolant will escape through the leak off tube into the containment environment, or if the secondary seals were to fail, reactor coolant would leak by the crevice between the compression collar and pressurizer shell. No additional material will be exposed to the steam or steam water mixtures other than those described above and thus, there are no other corrosion issues resulting from this type event.

Summary

In summary, there are not any potential corrosion problems associated with the application of the MNSA-2 to Alloy 600 small diameter nozzles and heater sleeves. This assessment considered potential corrosion issues associated with the component base metal, the MNSA-2 materials of construction and galvanic effects.

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