Nuclear Operating Company

South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

June 25, 2003
NOC-AE-03001550
10CFR50.55a

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

South Texas Project
Unit 1
Docket No. STN 50-498
Request for Relief from ASME Section XI Requirements Associated with Characterizing Flaws in Bottom Mounted Instrument Penetration Welds
(Relief Request RR-ENG-2-33)

Pursuant to 10CFR50.55a(g)(5)(iii), STP Nuclear Operating Company (STPNOC) hereby requests NRC relief from the ASME Section XI Code requirements to (1) characterize flaws in the original J-groove weld and associated buttering of two repaired bottom mounted instrumentation (BMI) penetrations and (2) perform successive examinations of these areas during the current ten-year inspection interval. 10CFR50.55a Relief Request RR-ENG-2-33 is attached.

STPNOC requests approval on an expedited basis by July 31, 2003, based on the schedule for repairing BMI penetrations in the Unit 1 reactor pressure vessel during the current forced outage.

If there are any questions regarding this relief request, please contact Mr. Michael Lashley at 361-972-7523 or me at 361-972-7162.

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jtc

Attachment: 10CFR50.55a Relief Request RR-ENG-2-33

A047

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10CFR50.55a Relief Request RR-ENG-2-33

Relief Requested
In Accordance with 10CFR50.55a(g)(5)(iii)

--Inservice Inspection Impracticality--

1. ASME Code Components Affected

Reactor vessel bottom mounted instrumentation (BMI) nozzle penetrations. There are 58 BMI nozzles welded to the bottom head of the reactor vessel. The ASME Code Class is Class 1.

2. Applicable Code Edition and Addenda

ASME Code Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1989 Edition, no Addenda

3. Applicable Code Requirement

Section XI, Article IWA-3000 provides standards for examination evaluation.

> IWA-3100(a) states in part:
>
> Evaluation shall be made of flaws detected during an inservice examination as required by IWB-3000 for Class 1 pressure retaining components...
>
> IWA-3300(b) states:
>
> Flaws shall be characterized in accordance with IWA-3310 through IWA-3390 as applicable.

Section XI, Article IWB-3000 provides acceptance standards for Class 1 components.

> IWB-3420 states:
>
> Each detected flaw or group of flaws shall be characterized by the rules of IWA-3300 to establish the dimensions of the flaws. These dimensions shall be used in conjunction with the acceptance of IWB-3500.

Section XI, Article IWB-2000 provides examination and inspection requirements for Class 1 components.

> IWB-2420(b) states:
>
> If flaw indications or relevant conditions are evaluated in accordance with IWB-3132.4 or IWB-3142.4, respectively, and the component qualifies as acceptable for continued service, the areas containing such flaw indications or relevant conditions shall be reexamined during the next three inspection periods listed in the schedules of the inspection programs of IWB-2410.

4. Reason for Request

STP Nuclear Operating Company (STPNOC) conducted visual examinations of the reactor vessel BMI nozzle penetrations prior to startup from Unit 1 Refueling Outage 1RE11. These examinations revealed evidence of leakage in the annulus of two penetrations (Penetrations 1 and 46). Subsequent nondestructive examination (NDE) conducted from the nozzle bore of all penetrations confirmed the presence of flaws in the Alloy 600 nozzles of Penetrations 1 and 46 and verified no flaws existed in the nozzles of the other penetrations. The half-nozzle repair/replacement process has been implemented on the two flawed BMI nozzles. This process removed the lower portion of the BMI nozzle within and below the reactor vessel bottom head (RVBH) and replaced it with an Alloy 690 half-nozzle. A new pressure boundary J-groove weld was fabricated between the replacement nozzle and the RVBH outside surface. The upper portion of the Alloy 600 nozzle material remained in place, but it is no longer pressure retaining. The original J-groove weld on the RVBH inside surface became a non-structural attachment weld to the vessel. The final configuration is depicted in Figure 1.

The original J-groove weld was subject to an inservice inspection (ISI) VT-2 visual examination for reactor coolant leakage under both Section XI Examination Category B-P each inspection period and Examination Category B-E each inspection interval. There are three inspection periods in each ten-year inspection interval. Since the half-nozzle repair/replacement is now complete, the original J-groove weld is subject to an ISI VT-3 visual examination under Examination Category B-N-2 each inspection interval. The new J-groove weld outside the RVBH is subject to an ISI VT-2 visual examination for reactor coolant leakage under Section XI Examination Categories B-E and B-P.

Flaw initiation and/or growth in the remaining Alloy 600 nozzle material is not a concern from a code perspective since this nozzle remnant does not serve a pressure boundary or structural role. The nozzle remnant does have an operability function for the BMI thimble tubes, but any loss of material could impact the reactor vessel loose parts analysis. STPNOC has evaluated these functions and determined the nozzle remnants will continue to perform these functions.

Flaws may exist in the original J-groove weld and buttering of the repaired penetrations that cannot be characterized by NDE. The materials and configuration of the original J-groove weld and buttering do not permit characterization of flaws within these welds by available NDE technology. This relief request seeks approval for the two repaired BMI penetrations to remain in service without NDE characterization or successive examinations of potential flaws in the original J-groove weld, buttering, and adjacent RVBH base material based on a postulated flaw growth analysis and other bases as described below.

5. Proposed Alternatives and Bases for Use

5.1 IWA-3100(a), IWA-3300(b), and IWB-3420

IWA-3100(a) requires that flaws in Class 1 components be evaluated for acceptability in accordance with the requirements of Article IWB-3000. Additionally, IWA-3300(b) and IWB-3420 require that flaws be characterized by type, location, dimensions, etc., to allow comparison with acceptance standards and determine acceptability and the need for repair, replacement, etc. Since flaws were detected and characterized in the nozzle material adjacent to the J-groove welds of Penetrations 1 and 46, flaws have conservatively been postulated in the J-groove weld of these penetrations. Since the repair/replacement method for BMI nozzles will not remove the original J-groove weld or its buttering from service, the concern is that potential flaws in these welds could continue to grow.

Due to the materials and geometry of the weld area, the current state of NDE technology is not adequate to detect and characterize flaws in these welds. Therefore, it is not practical to comply with the Section XI Code requirements cited above for flaw characterization and acceptance evaluation. However, a flaw growth evaluation of these welds, and a stress and fatigue analysis of the modified configuration, combined with industry experience in primary water stress corrosion cracking (PWSCC) growth in low alloy materials, provide an alternative basis for demonstrating the structural integrity of these welds.

The original BMI J-groove weld configuration is extremely difficult to examine with ultrasonic examination (UT) techniques from inside the vessel due to the compound curvature of the RVBH. If UT examination of the J-groove weld were attempted from inside the vessel, both the cladding interface and weld buttering interface would provide an acoustic mismatch that would severely limit a confident examination of the J-groove weld material. Additionally, access to the RVBH inside surface for UT examinations of the J-groove weld would be a hardship because of the requirement to remove the fuel and vessel internals.

The expected orientation of flaws propagating through the J-groove weld and buttering and into the low alloy base material is radial-axial with respect to the BMI nozzle. If a UT examination of the original J-groove weld were attempted from the outside surface of the RVBH, the J-groove buttering interface would provide an acoustic mismatch that would severely limit this examination. This UT examination would also encounter problems due to the compound curvature of the head and would require long examination distances (i.e., metal paths) for interrogation of radial-axial oriented flaws at the opposite (inside) surface. These conditions would make accurate detection, characterization, and sizing of flaws very difficult. Additionally, UT examinations performed from the RVBH outside surface would be performed in a "Locked - High Radiation Area." Currently there is no qualified UT examination technique for examination of the original J-groove welds, buttering, or adjacent low alloy RVBH material from either the inside or outside surface of the RVBH.

Radiography of this area is impractical due to inability to position either a source or film inside the RVBH. Dye penetrant, magnetic particle, and eddy current examinations would not provide useful volumetric information.

Therefore, it is impractical and presently the technology does not exist to characterize flaws that may exist in the original J-groove weld, buttering, or adjacent RVBH base material. Not only is the configuration not conducive to UT, but the dissimilar metal interfaces between the cladding and low alloy steel RVBH and between the buttering and low alloy steel RVBH increase the UT difficulty. This inability to characterize the flaw will continue in the foreseeable future and subsequent examinations will also be impractical.

STPNOC proposes to accept BMI nozzle Alloy 182 J-groove and buttering weld flaws by analysis of the worst case that might exist in these welds. This analysis will provide an acceptable level of quality and safety in ensuring that the RVBH remains capable of performing its design function with potential flaws in the original J-groove weld and buttering.

In lieu of flaw characterization, ASME Section XI calculations have been performed to show the flaws are acceptable. STPNOC has postulated flaws in these welds that extend from the J-groove weld surface to the butter-to-RVBH base material interface. Based on extensive industry experience, there are no known cases where flaws initiating in an Alloy 82/182 weld have propagated into the ferritic base material.

The worst-case assumption on flaw size is based on maximum crack growth by PWSCC. Although a crack propagating through the J-groove weld by PWSCC would eventually grow to the low alloy steel RVBH, continued growth by PWSCC into the low alloy steel is not expected to occur. Stress corrosion cracking (SCC) of carbon and low alloy steel is not a problem under pressurized water reactor conditions. SCC of steels containing up to 5% chromium is most frequently observed in caustic and nitrate solutions and in media containing hydrogen sulfide. Based on this information, SCC is not expected to be a concern for low alloy steel exposed to primary water. Instead, an interdendritic crack propagating from the J-groove weld area is expected to blunt and cease propagation.

The surface examinations performed associated with flaw removal during repairs at the following plants support the assumption that the flaws would blunt at the interface of the Ni-Cr-Fe weld to ferritic base material (Ref. 1):

- Oconee 1 & 3 reactor vessel head control rod drive mechanism penetrations
- Catawba 2 steam generator channel head drain connection penetration
- ANO-1 hot leg level tap penetrations
- V. C. Summer hot leg pipe-to-primary outlet nozzle repair

An analysis of the modified BMI nozzle configuration was performed using a three-dimensional model of a BMI nozzle located at the most severe hillside orientation. The software program ANSYS (general purpose finite element program used industry-wide) was used for this analysis. The ANSYS computer code is independently verified as executing properly by the solution of verification problems using ANSYS and then comparing the results with independently determined results.

The analytical model included the modified BMI nozzle configuration including the Alloy 600 nozzle remnant and original J-groove weld. The model was analyzed for thermal transient conditions as contained in the STP design specifications. The resulting maximum thermal gradients were applied to the model along with the coincidental internal pressure values. The ANSYS program then calculated the stresses throughout the model (including the original and new welds). The stresses were post-processed by ANSYS routines to categorize stresses consistent with the criteria of the ASME Code.

The calculated stresses are compared to ASME Code Section III, NB-3000 criteria for:

- Design conditions
- Normal, operating, and upset conditions
- Emergency conditions
- Faulted conditions
- Testing conditions

An ASME Section XI flaw growth analysis has been performed to show the flaws are acceptable for at least 40 additional years of plant operation. The only driving mechanism is fatigue crack growth. The evaluation assumed a radial-axial crack with a length equal to the partial penetration weld preparation depth.

A fracture mechanics evaluation has verified that degraded J-groove weld metal and buttering may be left in the vessel with no examination to characterize any flaws that may be located in these welds. Since the hoop stresses in the J-groove weld are generally about two times the axial stress at the same location, the preferential direction for cracking is radial-axial relative to the nozzle. It was postulated that a radial-axial crack in the Alloy 182 weld metal would propagate due to PWSCC, through the weld and butter, to the interface with the low-alloy steel vessel head. It is fully expected that such a crack would then blunt and arrest at the butter-to-head interface. Ductile crack growth through the Alloy 182 metal would tend to relieve the stresses in the weld as the crack grew to its final size and blunted. Although residual stresses in the vessel head material are low, it was assumed that a small flaw could initiate in the low-alloy steel material and grow by fatigue. It was postulated that a small flaw in the vessel head would combine with a large stress corrosion crack in the weld to form a radial corner flaw that would propagate into the low-alloy steel vessel head by fatigue crack growth under cyclic loading conditions associated with heatup and cooldown and other applicable transients.

Flaw evaluations were performed for a postulated radial corner crack on the vessel head penetration, where stresses are the highest and the radial distance from the inside corner to the low-alloy steel base material (crack depth) is the greatest. Hoop stresses were used because they are perpendicular to the plane of the crack. Fatigue crack growth, calculated for the remaining operational life, was small and the final flaw size was shown to meet the fracture toughness requirements of the ASME Code using an upper shelf value of 200 ksi √in. for ferritic materials.

STPNOC may remove boat samples from the BMI Alloy 600 nozzle base material of Penetrations 1 and 46 to obtain portions of known flaws in support of the root cause determination. If boat samples are removed, they will be extracted from inside the reactor vessel from the water side of the J-groove weld. Therefore, the boat sample will remove part of the J-groove weld and part of the Alloy 600 nozzle base material containing the flaw. The potential boat sample cavities will be left in the J-groove weld and nozzle material without repairing these cavities by welding. STPNOC will assure the effect of these potential boat sample cavities meet Section III stress analysis and Section XI flaw growth analysis requirements.

In conclusion, it has been shown to be acceptable to leave the postulated flaws in the original J-groove attachment weld, buttering, or adjacent low alloy base material. The evaluations performed in support of this relief request provide an equivalent acceptable level of quality and safety without performing flaw acceptance evaluation and flaw characterization as required in ASME Section XI, Paragraph IWA-3100(a) and Paragraphs IWA-3300(b) and IWB-3420, respectively.

5.2 IWB-2420(b)

Subsequent NDE of the J-groove weld and buttering to satisfy successive examination requirements is impractical. The postulated flaws are not in a pressure-retaining weld and, based on industry experience, they would arrest at the butter-to-low alloy base material interface. STPNOC has analyzed the postulated flaw as acceptable for continued service based on the flaw growing to the butter-to-low alloy base material interface and blunting. STPNOC has also analyzed postulated fatigue cracks in the RVBH base material in conjunction with PWSCC in the J-groove weld and buttering, and has determined that the Section XI evaluation criteria are satisfied. Therefore, based on the impracticality of the UT examinations described above and the provision of an acceptable level of quality and safety by Code evaluation and other bases, STPNOC requests relief from the successive inspections of the "as-left" J-groove weld, buttering, or adjacent RVBH base material required by IWB-2420(b). These successive examinations would not provide any meaningful information with respect to characterizing the flaws.

6. Duration of Relief

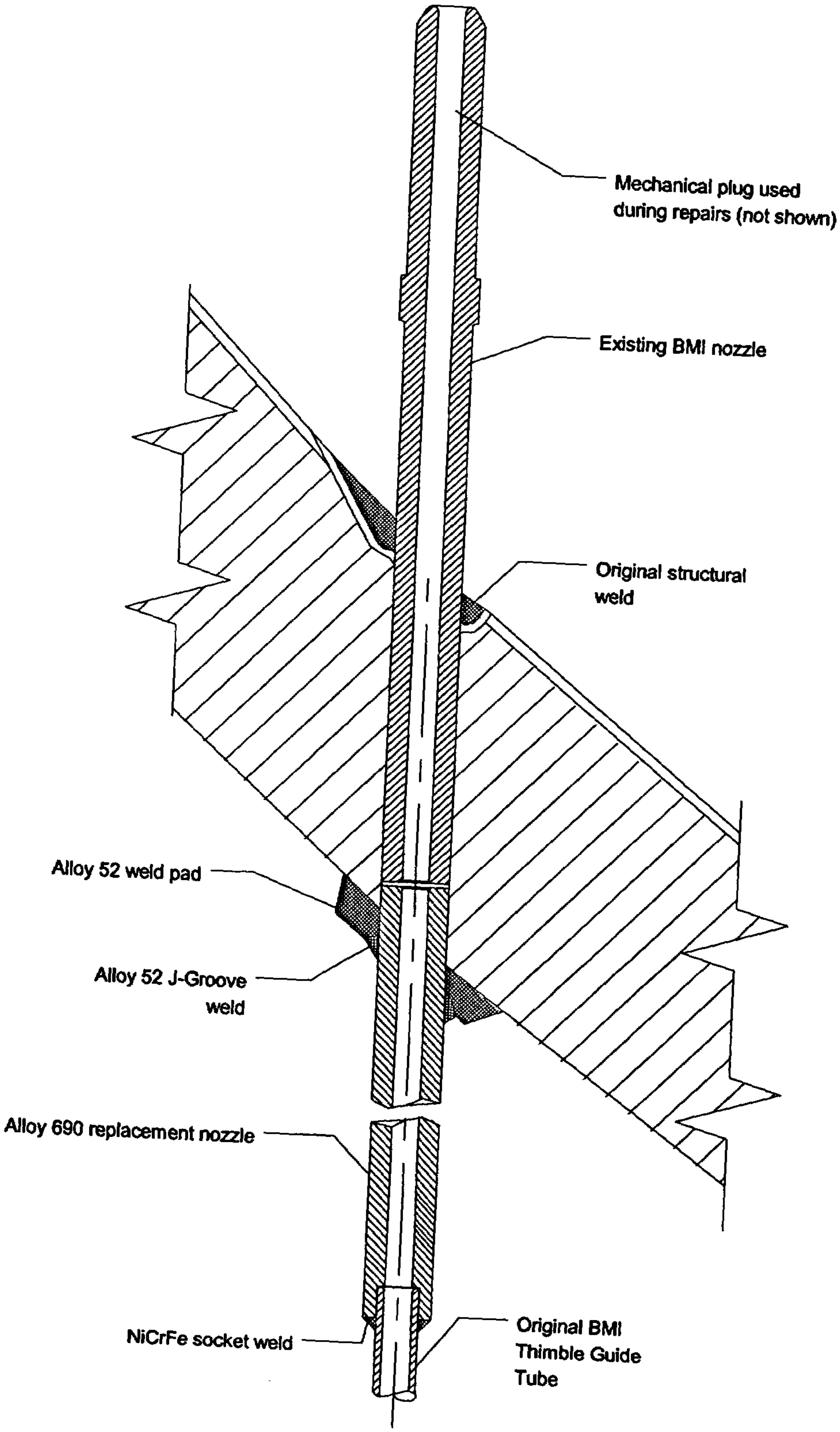
STPNOC requests this relief for the remainder of the second ten-year inspection interval of Unit 1.

7. Precedent

Turkey Point Units 3 & 4
Docket Nos. 50-250 and 50-251
TAC Nos. MB4311 and MB4312
April 25, 2003

8. References

1. "PWR Materials Reliability Project Interim Alloy 600 Safety Assessment for US PWR Plants (MRP-44), Part 1: Alloy 82/182 Pipe Butt Welds," dated April 2001



Final Configuration
Figure 1