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A. Edward Scherer
Manager of
Nuclear Regulatory Affairs

October 15, 2004

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

Subject: **Docket Nos. 50-361 and 50-362**
Third Ten-Year Inservice Inspection (ISI) Interval Relief Requests ISI-3-11, Revision 1 and ISI-3-12 to Support Potential Pressurizer Heater Sleeve Repairs.
San Onofre Nuclear Generating Station, Units 2 and 3

Reference: Letter from A. E. Scherer (SCE) to the Document Control Desk, (NRC) dated March 22, 2004; Subject: Docket Nos. 50-361 and 50-362, Third Ten-Year Inservice Inspection (ISI) Interval Relief Request ISI-3-11 Regarding American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-638 Similar and Dissimilar Metal Welding Using Ambient Temperature Machine Gas Tungsten Arc Welding (GTAW) Temper Bead Technique to Support Potential Pressurizer Nozzle Repairs, San Onofre Nuclear Generating Station, Units 2 and 3

Dear Sir or Madam:

Pursuant to 10 CFR 50.55a(a)(3)(i), Southern California Edison (SCE), San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 is submitting Relief Requests ISI-3-11, Revision 1 and ISI-3-12 for review and approval, and is hereby withdrawing Relief Request ISI-3-11, submitted on March 22, 2004 (Referenced).

During the Unit 3 Cycle 13 Refueling Outage, SCE is performing examinations of SONGS Unit 3 Pressurizer heater sleeve penetrations. Depending on the results of these examinations, SCE may elect or need to implement repairs as described in Enclosure 1. The approval of the enclosed relief requests (Enclosures 2 and 3) will be needed to complete the sleeve repairs.

A047

P.O. Box 128
San Clemente, CA 92674-0128
949-368-7501
Fax 949-368-7575

Relief Request ISI-3-11, Revision 1 (Enclosure 2) is seeking relief from the requirements of Article IWA-4600 of the Boiler and Pressure Vessel Code, Section XI. The applicable Construction Code is the 1971 Edition through Summer 1971 Addenda of ASME Section III.

Relief Request ISI-3-12 (Enclosure 3), is seeking relief from the 1995 Edition through 1996 Addenda of ASME Section XI, IWA-3300, Flaw Characterization and IWB-2420 Successive Inspections. In lieu of fully characterizing any remaining cracks and performing successive examinations to validate flaw stability, SCE proposes, as described in the relief request, to utilize worst-case assumptions to conservatively estimate the crack extent and orientation.

The planned repair is similar to repairs performed previously at Three Mile Island, Crystal River Unit 3, Millstone, St. Lucie, Arkansas Nuclear One, Unit 1, South Texas Project, and other facilities.

SCE is requesting expedited review and approval of these relief requests to support reaching MODE 4 in the Unit 3 Cycle 13 Refueling Outage, which is currently planned for November 12, 2004.

Should you have any questions, please contact Mr. Jack Rainsberry at (949) 368-7420.

Sincerely,

Enclosures:

1. Background and Description of the Planned Repair
2. Relief Request ISI-3-11, Revision 1
3. Relief Request ISI-3-12
4. Summary of Analyses Performed to Support Welded Sleeve Repair

cc: B. S. Mallett, 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 and 3

Southern California Edison

San Onofre Nuclear Generating Station, Units 2 and 3

Docket Nos. 50-361 and 50-362

Enclosure 1

BACKGROUND
AND DESCRIPTION OF THE PLANNED REPAIR

BACKGROUND AND DESCRIPTION OF THE PLANNED REPAIR

The Pressurizer heater sleeves are small bore (1.660" O.D.) penetrations through the lower head of the Pressurizer vessel. The proposed repair process, termed a half sleeve repair, removes a portion of the existing sleeve outside the vessel. A weld buildup (i.e., weld pad) will be formed on the exterior of the vessel wall centered at the sleeve opening. The weld pad will be applied using the machine gas tungsten arc welding (GTAW) ambient temperature temper bead process.

This weld pad will then be machined to accept a new Ni-Cr-Fe Alloy 690 sleeve that is attached using a partial penetration "J" groove weld. A new sleeve-to-shell weld will be installed at the weld pad. The original weld will no longer function as the pressure boundary sleeve-to-vessel weld.

The original weld, and a portion of the original sleeve within the vessel wall thickness, will remain in place at the junction of the sleeve to vessel inside surface. This weld and sleeve portion has been analyzed for acceptability to remain in place. It is also assumed that any flaws will remain in the original sleeve to shell weld and will not be removed.

Southern California Edison (SCE) will conduct the repairs in accordance with related portions of the 1995 Edition through 1996 Addenda of the American Society of Mechanical Engineers (ASME) Section XI (as applicable) and the 1971 Edition through Summer 1971 Addenda of Section III (except for nondestructive examination (NDE) methodology and acceptance criteria, as noted above) and the alternative requirements as discussed in Relief Request ISI-3-11, Revision 1 (Enclosure 2), and Relief Request ISI-3-12 (Enclosure 3).

In lieu of a hydrostatic pressure test, SCE intends to perform a system leak test using the provisions in ASME XI, IWA-4540(a)(2), 1998 Edition through 2000 Addenda. SCE's current code of record, the 1995 Edition through 1996 Addenda, permits the use of specific provisions from a later Edition/Addenda to be used in IWA-4150(b). The NRC has previously approved the use of ASME XI, 1998 Edition through 2000 Addenda per 10 CFR 50.55a.

Relief Request ISI-3-11, Revision 1 (Enclosure 2), is seeking an alternative to the requirements in IWA-4600 to perform a portion of the repair with a remotely operated welding machine, utilizing the machine Gas Tungsten-Arc Welding (GTAW) process and the ambient temperature temper bead method with 50°F minimum preheat temperature and no post weld heat treatment, as described in Code Case N-638.

Relief Request ISI-3-12 (Enclosure 3) is seeking relief from the 1995 Edition through 1996 Addenda of ASME Section XI, IWA-3300, Flaw Characterization and IWB-2420 Successive Inspections. In lieu of fully characterizing the remaining cracks and performing successive examinations, SCE proposes, as described in the relief request, to utilize worst-case assumptions to conservatively estimate the crack extent and orientation.

The repair technique and ASME Code Relief described above is consistent with Crystal River submittals dated October 5, 2003 and October 11, 2003, and NRC approval dated January 6, 2004.

Southern California Edison

San Onofre Nuclear Generating Station, Units 2 and 3

Docket Nos. 50-361 and 50-362

Enclosure 2

RELIEF REQUEST ISI-3-11, REVISION 1

REFERENCE CODES: The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code: Section XI, 1995 Edition through 1996 Addenda

I. **System/Component(s) for Which Relief is Requested:**

a) Name of component:

Pressurizer Heater Sleeve penetrations. There are 30 heater sleeve penetrations through the lower head of each Pressurizer vessel.

b) Function:

The sleeves and penetration welds serve as primary pressure boundary components.

c) ASME Code Class:

The Pressurizer heater sleeve penetrations are ASME Class 1.

d) Category:

Examination Category B-P, All Pressure Retaining Components; Item No. B15.20 applies to the original unmodified and modified locations at the new welds.

II. Current Code Requirement and Relief Request:

a) ASME B&PV Code, Section XI 1995 Edition through 1996 Addenda, IWA-4410 requires repairs to be made in accordance with the Owner's Requirements and the original Construction Code (ASME III) of the component or system. Later Editions and Addenda of the Construction Code, either in their entirety or portions thereof, and Code Cases may be used. If repair welding cannot be performed in accordance with these requirements, the applicable alternative requirements of IWA-4600 may be used.

b) In accordance with 10CFR50.55a(a)(3)(i), Southern California Edison (SCE), San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 is requesting relief from the following portion of ASME Section XI, IWA-4410 and its referenced IWA-4600 to perform Pressurizer heater sleeve penetration repairs:

"Alternatively, the applicable requirements of IWA-4600 may be used for welding . . ."

In lieu of performing the repair using the alternative welding techniques described in IWA-4600, SCE is proposing to perform a portion of the repair with a remotely operated welding machine, utilizing the machine Gas Tungsten-Arc Welding (GTAW) process and the ambient temperature temper bead method with 50°F minimum preheat temperature and no post weld heat treatment (PWHT), as described in Code Case N-638. SCE is requesting the use of the Code Case in its entirety, except for deviations as listed in Table 1, below. The description of the proposed alternative is provided in the following section.

c) In lieu of a hydrostatic pressure test, SCE intends to perform a system leak test using the provisions in ASME XI, IWA-4540(a)(2), 1998 Edition through 2000 Addenda. SCE's current code of record, the 1995 Edition through 1996 Addenda, permits the use of specific provisions from a later Edition/Addenda to be used in IWA-4150(b). The NRC has previously approved the use of ASME XI, 1998 Edition through 2000 Addenda per 10 CFR 50.55 a.

d) SCE has determined that the proposed alternative will provide an acceptable level of quality and safety, while allowing significant dose reductions.

III. Alternate Criteria for Acceptability:

SCE may elect or need to perform Pressurizer heater sleeve repairs as follows:

1. Mechanical removal of a portion of the existing sleeve.

2. Application of a weld pad (or weld buildup) using F-No. 43 to the Pressurizer shell (P-No. 3, Group 3) base material.

3. Machining the weld pad to accept the new alloy 690 sleeve (P-No. 43).

4. Installing the replacement sleeve by using conventional manual gas tungsten arc welding (GTAW) and a "J" groove partial penetration weld.

The proposed alternative to the applicable portion of ASME, Section XI involves the use of the ambient temperature temper bead repair described in Code Case N-638. This methodology is proposed to be used only for the weld pad application, Step 2 of the repair process. Code Case N-638 was approved for use in Regulatory Guide 1.147, Revision 13 (June 2003).

Table 1 was prepared as a means to readily describe those areas where the proposed methodology deviates from the requirements of the original construction code, ASME XI, or the code case.

Table 1		
Reference	Requirement	Alternative, Including Reference for Justification
ASME Section III Relief		
NB-3357	"All vessels and vessel parts shall be given the appropriate postweld heat treatment prescribed in NB-4620"	50°F minimum preheat temperature and no post-weld heat treatment (PWHT) performed as described in Code Case N-638. {See IV.2.b & c below}
NB-4622.1	Except as otherwise stated in the Notes to Table NB-4622.1-1, all welded components or pieces of components shall be given a final postweld heat treatment at a temperature not less than specified in Table NB-4622.1-1.	50°F minimum preheat temperature and no PWHT performed as described in Code Case N-638. {See IV.2.b & c below}
Note 1.B to Table NB-4622.1-1	. . . postweld heat treatment is mandatory for ... and SA-533 material for all thicknesses	50°F minimum preheat temperature and no PWHT performed as described in Code Case N-638. {See IV.2.b & c below}
NB-6111.1	All components and appurtenances constructed and/or installed under the rules of this Section of the Code shall be hydrostatically tested, in the presence of the Inspector.	System leak test will be performed in lieu of a hydrotest per IWA-4540 (a)(2),1998 Edition, 2000 Addenda.

Table 1		
Reference	Requirement	Alternative, Including Reference for Justification
ASME Section XI	RELIEF	
IWA-4600(b)(1)	When postweld heat treatment is not to be performed, the welding methods of IWA-4630 (for dissimilar materials) may be used in lieu of welding and NDE requirements of ASME III, provided requirements of IWA-4610 are met.	Code Case N-638 will be used in lieu of IWA-4600. {See IV.2.b & c below}
IWA-4610(a)	For GTAW process, weld area and 5" band shall be preheated to 300°F minimum; Maximum interpass temperature of 450°F to be used	Qualification test and field welding process per Code Case N-638; 50°F minimum preheat; 150°F maximum interpass temperature to be used for the procedure qualification and 350°F maximum for field welding. {See IV.2.b and c below}
IWA-4610(a)	Thermocouples and recording instruments shall be used for monitoring process temperatures	A contact pyrometer will be used for monitoring preheat and interpass temperatures in lieu of thermocouples and recording instruments. Interpass temperatures to be monitored on first three layers of each repair location. In first repair location, interpass temperatures to be measured every three to five passes. Subsequent repair locations will be measured every six to ten passes. {See IV.2.d below}
IWA-4633.2(c)	Six temper bead layers are required.	Code Case N-638 requires three temper bead layers. {See IV.2.c below}
IWA-4633.2(d)	After at least 3/16" deposit, the weld area shall be maintained at 300°F for 4 hours minimum (P-No. 3 materials)	Post Weld Heat Soak not used per Code Case N-638. {See IV.2.c below}

Table 1		
Reference	Requirement	Alternative, Including Reference for Justification
CODE CASE N-638 RELIEF		
N-638	Code Case provides relief to allow use of machine GTAW with ambient temperature preheat and no PWHT when draining vessel is impractical	This methodology is applied due to dose considerations, even though the vessel can be drained. This philosophy is in accordance with the SONGS ALARA program. {See IV.2.a below}
N-638	The Code Case requires surface examination and volumetric examination (UT) of a 5 inch band of base metal surrounding the weld repair area after the 48 hour hold time.	Only a surface examination of the 5 inch band surrounding the weld (PT or MT) will be performed. {See IV.2.e below}

IV. Basis for Relief:

The basis for the relief request is that the use of an ambient temperature temper bead welding process provides an equivalent acceptable level of quality and safety when compared to the welding process in ASME, Sections XI and III, while offering substantial savings in accumulated radiation dose. In support of this conclusion, the process is described below, followed by technical justification for the technique, as well as the expected dose savings.

1. <u>**Description of the process**</u>

Figure 1 provides a general overview of the configuration.

a) Volumetric examinations or visual inspections for leakage/boric acid deposits of the Pressurizer heater sleeve penetrations may identify a need to repair a pressurizer heater sleeve. SCE plans to use remote machine processes similar to those used previously at other facilities, including Crystal River Unit 3, South Texas Project, Arkansas Nuclear 1, Unit 1 (ANO), and Millstone.

b) The sleeve will be cut close to the Pressurizer shell. A portion of the sleeve inside the vessel bore will then be removed by machining and the area around the sleeve will be prepared for the application of the weld pad by grinding smooth and performing a surface examination

(PT or MT) and ultrasonic examination of the area to be welded and the 5 inch wide band surrounding the weld area.

c) A weld pad will be applied to the surface of the Pressurizer shell using the ambient temperature temper bead weld process and GTAW method as described in Code Case N-638. The weld pad is to be applied as a weld buildup centered on the existing sleeve opening.

d) The weld pad will be prepared suitable for nondestructive examination (NDE). The pad and its heat affected zone (HAZ) below the pad will be volumetrically examined (UT) to the extent practical. The weld pad and a 5-inch wide band surrounding the weld pad will also be surface examined (PT or MT). The examinations and acceptance criteria will be in accordance with ASME III, 1995 Edition through 1996 Addenda, NB-5000.

   Ultrasonic examinations, before and after welding, of the full parent material thickness beneath the weld pad, to the extent practical, are performed to discern laminar type indications therein. Laminar type indications observed will be recorded and evaluated to assure the structural integrity of the modification configuration is not adversely affected.

e) The center of the weld pad will be ground or machined to re-establish a free path into the Pressurizer penetration. The weld pad will be prepared to accept the new sleeve using a "J" groove partial penetration weld.

f) The new sleeve will be inserted and welded using conventional welding and NDE techniques (manual GTAW and progressive PT). Note that this weld is in full ASME construction code compliance and relief from code requirements is not required.

2. **Justification**

   a) As low as reasonably achievable (ALARA)

   Experience gained from the performance of similar repairs/ modifications at other plants indicate that remote automated repair methods reduce the radiation dose to repair personnel and still provide acceptable levels of quality and safety. SCE is aware that ASME has revised Code Case N-638 to reflect the acceptability of this method for ALARA considerations as well as the inability to drain the vessel. SCE recognizes the importance of ALARA principles and this remote repair method is being proposed for the possibility of repairing pressurizer heater sleeves at SONGS.

This approach for the repair of Pressurizer sleeves will significantly reduce radiation dose to repair personnel while still maintaining acceptable levels of quality and safety. SCE estimates the dose accumulated providing access, installing heating pads and performing the preheat and post weld heat treatment required by the construction code would be approximately 1.8 REM per sleeve repair. Assuming that only one sleeve requires repair, use of the ambient temperature temper bead process results in a reduction of approximately 1.8 REM for the repair.

b) Procedure Qualification

Results of procedure qualification work undertaken to date on low alloy steel base material indicate that the ambient temperature temper bead process produces sound and tough welds. Industry experience also indicates that the machine GTAW ambient temper bead process has the capability of producing acceptable welds on P-No.3 Group No. 3 ferric steel base materials. Westinghouse-PCI (PCI), Welding Services (WSI), and Framatome ANP (FANP) have all qualified the welding process and procedures for this specific application in accordance with code and code case requirements prior to its use at SONGS.

These Code Case N-638 qualifications were performed at room temperature on P-No. 3 Group No. 3 base materials with ERNiCrFe-7 weld filler and similar low heat input controls that will be used for this repair application. These qualifications did not include a post weld heat soak. The successful qualification of the ambient temperature temper bead welding process demonstrates that the proposed alternative provides an acceptable level of quality and safety.

To ensure the acceptability of the welding process procedures for the SONGS application, SCE will review the chosen contractor's welding procedure specification and qualification records and verify the qualifications meet all Code and Owner's Requirements and Code Case N-638. Additionally, SCE will require either a mock-up demonstration or documentation that a representative mock-up demonstration has been previously performed.

c) Weld Quality

The proposed alternative repair technique has been demonstrated as an acceptable method for performing Pressurizer sleeve repairs. The ambient temperature temper bead technique has been approved by the ASME committee per Code Case N-638. The ambient temperature temper bead technique has also been previously approved by the NRC as having an acceptable level of quality and safety and used successfully at several utilities (Three Mile Island, Crystal River Unit 3, Millstone, St. Lucie, ANO, South Texas Project, and others). This Code Case has been approved in Regulatory Guide 1.147, Revision 13. This approval indicates that the methodology is capable of producing quality in-situ repairs.

As documented in EPRI Report GC-111050, research shows that carefully controlled heat input and bead placement allow subsequent welding passes to relieve stress and temper the HAZ of the base material. The use of the machine GTAW temper bead process will allow precise control of heat input, bead placement, bead size, and contour as compared to the SMAW process. The very precise control over these factors afforded by the machine GTAW process provides effective tempering of the HAZ. The research in the EPRI Report and numerous procedure qualification tests performed on P-No. 3, Group No. 3 by the industry have shown that acceptable weld quality and HAZ impact toughness can be obtained using machine GTAW, ambient preheat, three controlled temper bead layers, and no post weld heat treatment.

Typically, preheat and post weld heat treatment are used to mitigate the effects of the solution of atomic hydrogen in ferritic materials prone to hydrogen embrittlement cracking. The machine GTAW temper bead process uses a welding process that is inherently free of hydrogen. The GTAW process relies on bare welding electrodes and bare wire filler metal with no flux to trap moisture. An inert gas blanket provides shielding for the weld and surrounding metal, which protects the region during welding from the atmosphere and the moisture it may contain and typically produces porosity free welds. In accordance with the weld procedure qualification, welding grade argon is used for the inert gas blanket. To further reduce the likelihood of any hydrogen evolution or absorption, specific controls will be used to ensure the welding electrodes, filler metal, and weld region are free of all sources of hydrogen. Argon flow rates are adjusted to assure adequate shielding of the weld without creating a venturi affect that might draw oxygen or water vapor from the ambient atmosphere into the weld.

d) Preheat and Interpass Temperature Measurement

Due to the location of the repair and area radiation dose rate, the placement of thermocouples for monitoring weld interpass temperature is determined to be not beneficial based on dose savings. Therefore, thermocouples are not planned for use to monitor interpass temperature during welding. Preheat and interpass temperatures for the weld pad will be measured using a contact pyrometer. Interpass temperature will be monitored for the first three layers of each repair location. On the first repair location, the interpass temperature measurements will be taken every three to five passes. At subsequent repair locations, interpass temperature measurements will be taken every six to ten passes. Heat input beyond the third layer will not have a metallurgical affect on the low alloy steel HAZ.

e) Examination

The pressure test provisions being used from ASME XI, IWA-4540(a)(2), 1998 Edition, through 2000 Addenda mandate that NDE methodology and acceptance criteria from ASME III, 1992 Edition or later be used. All examinations will be performed in accordance with ASME III, 1995 Edition through 1996 Addenda, NB-5000, using personnel qualified in accordance with IWA-2300 and/or NB-5500.

The area to be welded, plus a 5 inch surrounding band, will be surface examined (PT or MT) both prior to and following welding. All post weld exams will be performed after the required 48 hour hold time. The entire volume of the weld pad, to the extent practical, will be scanned from the face of the pad, using examination angles of 0°, 45° RL, 60° RL and an OD creeping wave. The examination volume shall include the weld-deposited material and the ferritic vessel HAZ.

Ultrasonic examination, before and after welding, of the full parent material thickness beneath the weld pad, to the extent practical, will be performed to discern laminar type indications therein. Laminar type indications observed will be recorded and evaluated to assure the structural integrity of the modification configuration is not adversely affected.

Because this is a surface application of the temper bead process, there will be minimal impact to the volume of metal of the Pressurizer vessel in the area surrounding the weld. Since this weld is applied to the exterior surface of the Pressurizer, there is no additional useful information that can be gained by a volumetric examination of the area surrounding the weld. The weld and HAZ below will be post weld volumetrically examined to the extent possible. This reduction in the post welding inspection will provide additional dose reduction for this repair while still ensuring sound weld metal is deposited and that the process has not introduced flaws in the base material.

f) **Corrosion**

The automated repair method described above leaves an area of ferritic low alloy steel at the outside diameter (OD) of the sleeve [inside diameter (ID) of the sleeve bore] exposed to the primary coolant. The effect of corrosion on the exposed area, including reduction in vessel wall thickness, has been evaluated by Aptech Engineering Services and concurred with by SCE (SONGS Document M-DSC-402). The analysis shows that the total corrosion is insignificant when compared to the thickness of the vessel shell. SCE has determined that the expected extremely low rate of material loss will provide an acceptable level of safety.

g) **Stresses**

Design stress analysis of the modified heater sleeve weld attachments was performed (see Enclosure 4). The stress analysis demonstrates that the modified heater sleeve configuration complies with the criteria of NB-3000, ASME Section III, 1971 through Summer 1971 Addenda, as described in the calculations referenced in Enclosure 4, using design and service conditions applicable to the Pressurizer.

Therefore, based on the discussion above, SCE has determined that the proposed alternative provides an acceptable level of quality and safety while reducing radiation exposure to as low as reasonably achievable.

V. Documentation:

The use of the Code Cases and this Relief Request shall be documented on the NIS-2 Form for each repair.

VI. Implementation Schedule:

This relief request is being implemented during the Third Inservice Inspection Interval and it is only applicable to the repairs to the Pressurizer heater sleeves. SONGS third ten-year Inservice Inspection Interval began on August 18, 2003 and is scheduled to end on August 17, 2013.

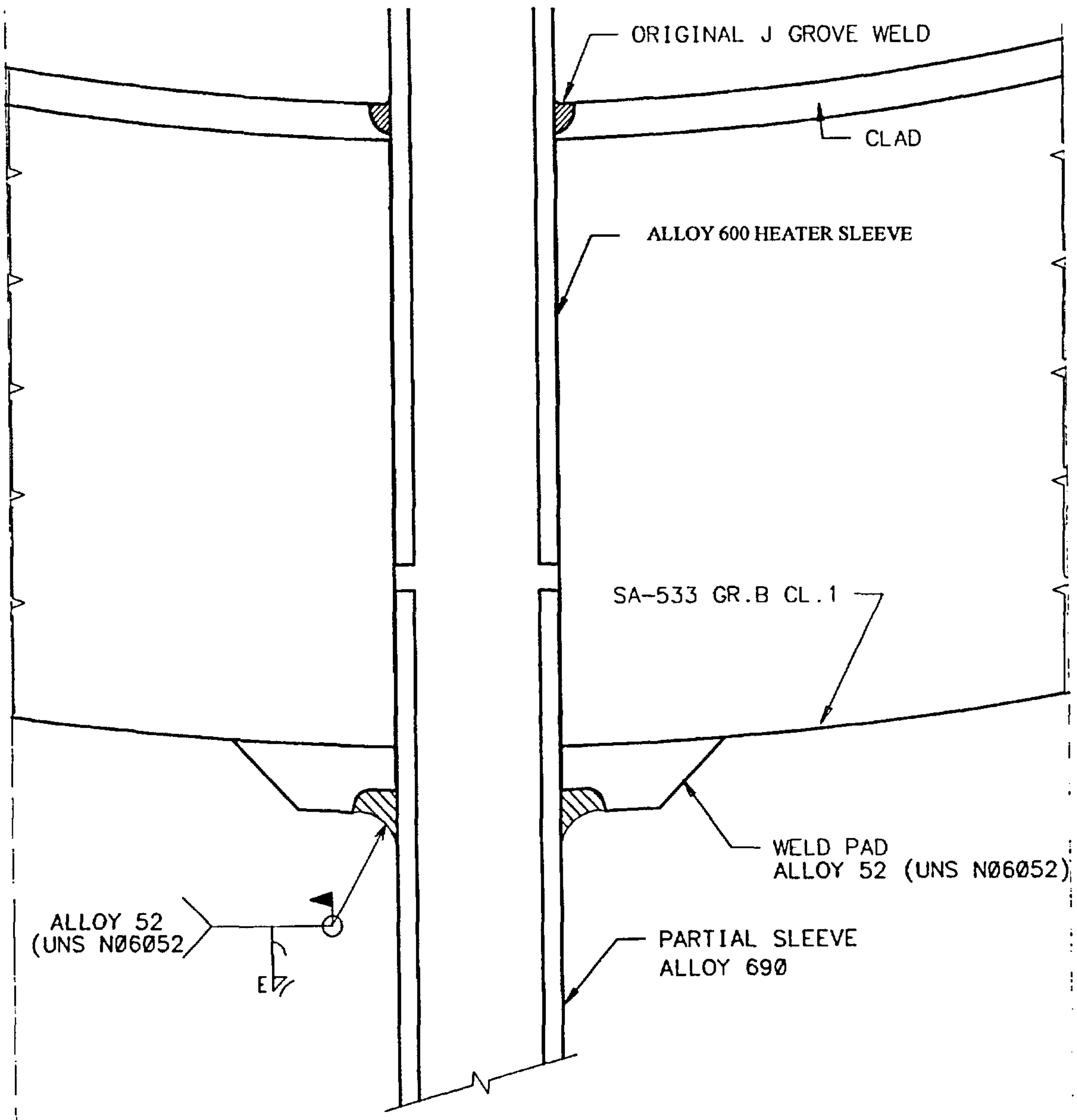
VII. Precedents:

Letter from James H. Terry (Progress Energy) to the Document Control Desk (NRC) dated October 5, 2003; Subject: Crystal River Unit 3 - Relief Requests 03-0001-RR, Revision 0, and 03 - 0002-RR, Revision 0

Letter from James H. Terry (Progress Energy) to the Document Control Desk (NRC) dated October 11, 2003; Subject: Crystal River Unit 3 - Supplemental Information to Relief Request 03-0001-RR, Revision 0

Letter from Allen G. Howe (NRC) to Dale E. Young (Crystal River Nuclear Plant) dated January 6, 2004; Subject: Crystal River Unit 3 – Safety Evaluation of Relief Requests 03-001[sic]-RR and 03-0002-RR Concerning Alternative Repair Method and Flaw Characterization for Pressurizer Instrument Nozzle Penetrations (TAC NOS. MC0947 and MC0963)

Figure 1



**Typical Half Sleeve Repair
For Pressurizer Heater Sleeve**

Southern California Edison

San Onofre Nuclear Generating Station, Units 2 and 3

Docket Nos. 50-361 and 50-362

Enclosure 3

RELIEF REQUEST ISI-3-12

INSERVICE INSPECTION
RELIEF REQUEST ISI-3-12
THIRD TEN YEAR INTERVAL

REFERENCE CODE: The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, 1995 Edition through 1996 Addenda

1. System/Component(s) for Which Relief is Requested:

a) Name of component:

Pressurizer Heater Sleeve penetrations. There are 30 heater sleeve penetrations through the lower head of each Pressurizer vessel.

b) Function:

The sleeves and penetration welds serve as primary pressure boundary components.

c) ASME Code Class:

The Pressurizer heater sleeve penetrations are ASME Class 1.

d) Category:

Examination Category B-P, All Pressure Retaining Components; Item No. B15.20 applies to the original unmodified and modified locations at the new welds.

2. Current Code Requirement and Relief Request:

In lieu of a hydrostatic pressure test, SCE intends to perform a system leak test using the provisions in ASME XI, IWA-4540(a)(2), 1998 Edition through 2000 Addenda. SCE's current code of record, the 1995 Edition through 1996 Addenda, permits the use of specific provisions from a later Edition/Addenda to be used in IWA-4150(b). The NRC has previously approved the use of ASME XI, 1998 Edition through 2000 Addenda per 10 CFR 50.55 a.

IWA-4611.1 requires in part that, "Defects shall be removed or reduced in size in accordance with this Paragraph." Furthermore, IWA-4611.1 allows that "...the defect removal and any remaining portion of the flaw may be evaluated and the component accepted in accordance with the appropriate flaw evaluation rules of Section XI." ASME Section XI, IWA-3300 requires characterization of flaws detected by inservice examination.

SCE is requesting relief from ASME Section XI, IWA-3300. It is assumed that flaws in the original Pressurizer heater sleeve to Pressurizer J-groove weld will not be removed. In lieu of fully characterizing the existing cracks, SCE proposes to utilize worst-case assumptions to conservatively estimate the crack extent and orientation. SCE has determined that the proposed alternative will provide an acceptable level of quality and safety, while allowing significant dose reductions.

IWB-2420 requires successive examinations of flaws evaluated in accordance with IWB 3132.3 or IWB 3142.4.

SCE is requesting that no additional inspections be performed to observe flaw stability because initial flaw characterization is not being performed. Thus, the actual dimensions of the flaw will not be fully determined. In lieu of fully characterizing any cracks that exist, and performing successive examinations SCE proposes to utilize worst-case assumptions to conservatively estimate the crack extent and orientation. Then, the postulated crack extent and orientation will be evaluated using the appropriate rules of ASME XI. SCE has determined that the proposed alternative will provide an acceptable level of quality and safety, while allowing significant dose reductions.

3. Alternate Criteria for Acceptability:

In lieu of the requirements of IWA-3300 and IWB-2420, per 10 CFR 50.55a(a)(3)(i), the following alternative is proposed:

The planned repair for the subject Pressurizer heater sleeves does not include removal of any flaws assumed to be present in the remaining J-groove partial penetration welds. Therefore, per the requirements of IWA-4611.1, the cracks must be evaluated using the appropriate flaw evaluation rules of Section XI. In addition, no additional examinations are planned to characterize the cracks. Thus, the actual dimensions of the flaw will not be fully determined. If a flaw is not fully characterized, the requirements for successive inspections of IWB-2420 become futile in that there is no reference point from which to evaluate changes in the flaw characteristics. In lieu of fully characterizing the existing cracks, SCE will utilize worst-case assumptions to conservatively estimate the crack extent and orientation. Then the postulated crack extent and orientation will be evaluated using the rules of IWB-3600.

4. Basis for Relief:

Volumetric examinations or visual inspections of the Pressurizer heater sleeve penetrations may identify a need to repair the pressurizer heater sleeve as follows:

1. Mechanical removal of a portion of the existing sleeve.

2. Application of a weld pad (or weld buildup) using F-No. 43 to the Pressurizer shell (P-No. 3, Group 3) base material.

3. Machining the weld pad to accept the new alloy 690 sleeve (P-No. 43).

4. Installing the replacement sleeve by using conventional manual gas tungsten arc welding (GTAW) and a "J" groove partial penetration weld.

The existing sleeve(s) and weld(s) will no longer function as the pressure boundary. However, the possible existence of cracks in these welds mandates that the potential for flaw growth be evaluated. The requirements of IWA-4611.1 allow two options for determining the disposition of discovered cracks. The subject cracks are either removed as part of the repair process or left as-is and evaluated per the rules of IWB-3600. The repair design dictates that the inside weld and sleeve portion be left intact inside the vessel.

The assumptions of IWB-3500 are that the cracks are fully characterized to be able to compare the calculated crack parameters to the acceptable parameters provided in IWB-3500. In the alternative being proposed, the acceptance of the postulated crack is calculated based on the two inputs of expected crack orientation and the geometry of the weld.

Typically, an expected crack orientation is evaluated based on prevalent stresses at the location of interest. Using worst case (maximum) assumptions with the geometry of the as-left weld, the postulated crack is assumed to begin at the inside surface of the heater sleeve and penetrates the heater sleeve wall, and through to the intersection of the vessel inner diameter surface and the vessel sleeve penetration bore and propagate into the vessel wall low alloy steel. The depth and orientation are worst-case assumptions for cracks that may occur in the remaining J-groove partial penetration weld configuration. It is assumed that the "as-left" condition of the remaining J-groove weld includes degraded or cracked weld material.

A fracture mechanics evaluation has been performed (Calculation M-DSC-402) in accordance with ASME Section XI evaluation procedures of IWB-3600. The analysis determines if a degraded J-groove weld material could remain in the vessel, with no examination to size any flaws that might remain following the repair. Since the hoop stresses in the J-groove weld are higher than the axial stresses, the preferential direction for cracking is axial, or radial relative to the sleeve. It is postulated that a radial crack in the Alloy 182 weld metal would propagate by Primary Water Stress Corrosion Cracking (PWSCC) through the weld to the interface with the low alloy steel shell. It is fully expected that such a crack would then arrest at the weld-to shell interface.

Crack growth through the Alloy 182 material would tend to relieve the residual stresses in the weld as the crack grows to its final size. Although residual stresses in the shell material are low, it is assumed that a weld flaw formed by PWSCC could grow into the low alloy steel material by fatigue. This flaw will form a continuous radial corner flaw that would propagate into the low alloy steel shell by fatigue crack growth under cyclic loading conditions.

Flaw evaluations are performed for a postulated radial corner crack. Hoop stresses are used since they are perpendicular to the plane of the crack. The life of the repair is determined based on fatigue crack growth and crack growth per year of operation. It has been calculated as 40 years of additional service. The final flaw size meets the fracture toughness requirements of the ASME Code using an upper shelf value of 200 ksi $in^{1/2}$ for unirradiated ferritic materials. The results of the analyses indicate that it is acceptable to leave the alloy 600 heater sleeve and original attachment J-groove weld in the vessel, even with the possibility that cracks exist in the weld for 40 years of service.

As noted above, radial cracks are postulated to occur in the weld due to the dominance of the hoop stress at this location. The occurrence of transverse cracks that could intersect the radial cracks is considered remote. There are no identified forces that would drive a transverse crack. Only thermal and welding residual stresses could cause a transverse crack to grow. However, the presence of radial cracks limits the growth potential of the transverse cracks. The radial cracks would relieve the potential transverse crack driving forces. Hence, it is unlikely that a series of transverse cracks could intersect a series of radial cracks resulting in any fragments becoming dislodged. Therefore the release of debris generated by a cracked weld is highly unlikely.

Additionally, SCE has previously evaluated the consequences of loose parts of similar or larger dimensions and mass being carried into the reactor vessel and concluded that the probability of damage to any RCS component is not significant (reference Action Request (AR) 960901028, assignment 8). For the heater sleeves in the pressurizer, the sleeve remnant is prevented from becoming a loose part by the pressurizer heater penetrating through the center of the remnant. In the unlikely event that a small part of the heater sleeve remnant breaks away, the density of the loose part material is significantly greater than that of the water, and the loose part would tend to settle to the bottom of the pressurizer. Flow velocities in the pressurizer are relatively low and are not likely to transport loose pieces of metal to the surge line. Additionally, the surge line nozzle is equipped with a surge screen, with half-inch holes. The evaluation in Action Request (AR) 960901028, assignment 8 concluded that no damage is expected in the event that the loose part does not remain in the bottom of the reactor.

The cited evaluations provide an acceptable level of safety and quality in insuring that the Pressurizer shell remains capable of performing its design function with flaws existing in the original J-groove weld. See Enclosure 4 for a summary of the supporting analyses.

Justification for Granting Relief

Removal of the cracks in the existing J-groove partial penetration welds would incur excessive radiation dose for repair personnel. With the installation of the new pressure boundary welds previously described, the original function of the J-groove partial penetration welds is no longer required. It is well understood that the cause of the cracks in the subject J-groove welds is Primary Water Stress Corrosion Cracking (PWSCC). As shown by industry experience, the low alloy steel wall of the Pressurizer impedes crack growth by PWSCC. SCE believes the alternative described will provide an acceptable level of quality and safety when compared to the code requirements in IWB-3500 to characterize the cracks left in service. Using flaw tolerance techniques, it has been demonstrated that the assumed worst case crack size will not grow to an unacceptable depth into the Pressurizer shell low alloy steel base material over the life of the repair. Thus, the Pressurizer shell can be accepted per the requirements of IWA-4611.1.

5. Implementation Schedule:

This relief request is being implemented during the Third Inservice Inspection Interval and it is applicable to repairs to the Pressurizer heater sleeve penetrations. SONGS third ten-year Inservice Inspection Interval began on August 18, 2003 and is scheduled to end on August 17, 2013.

6. Precedents:

Letter from James H. Terry (Progress Energy) to the Document Control Desk (NRC) dated October 5, 2003; Subject: Crystal River Unit 3 - Relief Requests 03-0001-RR, Revision 0, and 03 - 0002-RR, Revision 0

Letter from James H. Terry (Progress Energy) to the Document Control Desk (NRC) dated October 11, 2003; Subject: Crystal River Unit 3 - Supplemental Information to Relief Request 03-0001-RR, Revision 0

Letter from Allen G. Howe (NRC) to Dale E. Young (Crystal River Nuclear Plant) dated January 6, 2004; Subject: Crystal River Unit 3 – Safety Evaluation of Relief

Requests 03-001-RR and 03-002-RR Concerning Alternative Repair Method and Flaw Characterization for Pressurizer Instrument Nozzle Penetrations (TAC NOS. MC0947 and MC0963)

Southern California Edison

San Onofre Nuclear Generating Station, Units 2 and 3

Docket Nos. 50-361 and 50-362

Enclosure 4

SUMMARY OF ANALYSES PERFORMED TO SUPPORT WELDED SLEEVE REPAIR

RELIEF REQUEST ISI-3-11, REVISION 1

and

RELIEF REQUEST ISI-3-12

SUMMARY OF ANALYSES PERFORMED TO SUPPORT WELDED SLEEVE REPAIR

Calculation	Description	Summary
M-DSC-402 Rev. 0 Pressurizer Heater Sleeve J-Groove Weld Flaw Evaluation	Half-sleeve repair fatigue crack growth and borated water corrosion evaluation for Pressurizer Heater Sleeves.	1) This analysis evaluated the long-term impact of the newly exposed low alloy steel base metal (resulting from the repair) to reactor coolant. This analysis concluded that the corrosion rate is negligible and the corrosion depths after 40 years are less than the allowable corrosion depths. 2) This analysis also determined the impact of an assumed flaw in the existing J groove weld on low alloy steel base material. The analysis concluded that a postulated axial crack through the entire existing J groove weld would be acceptable for forty years following installation. This is based on an evaluation of fatigue crack growth into base metal. 3) The effect of the residual stresses in the existing pressurizer heater sleeve J-weld due to fabrication processes was included in the weld flaw evaluation.
M-DSC-356 Rev. 1 Evaluation of Modified Pressurizer Heater Sleeves	Half-sleeve repair for Pressurizer Heater Sleeves - ASME Section III Code evaluation	Analyzed the repairs to the requirements of ASME Section III. This analysis concluded that the stresses and fatigue meet the requirements of the Code and that repair life is forty years from time of installation.

SUMMARY OF ANALYSES PERFORMED TO SUPPORT WELDED SLEEVE REPAIR

Calculation	Description	Summary
Action Request (AR) 960901028 Assignment 8	Non Conformance Report. Evaluation of a potential loose part of similar size and mass.	Determined the probability of damage to any RCS component, as a result of a loose part is negligible.
Action Requests (AR) 970601575 and AR 030400092	Inspections of an instrument nozzle repaired using the proposed half-nozzle method at 5 and 10 years following the initial repair.	The Alloy 690 half nozzle was removed and the remnant was examined. Negligible to no wastage was observed. Therefore, Pressurizer shell wastage and release of iron will be negligible.