December 29, 2003

Mr. Roy A. Anderson
President & Chief Nuclear Officer
PSEG Nuclear, LLC - X04
Post Office Box 236
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NO. 2 - EVALUATION OF RELIEF REQUEST S2-I2-RR-A16 (TAC NO. MC0696)

Dear Mr. Anderson:

By letter dated September 10, 2003, PSEG Nuclear, LLC submitted Relief Request S2-I2-RR-A16 for the Salem Nuclear Generating Station, Unit No. 2. The request was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3)(i) as a proposed alternative to the requirements of the American Society of Mechanical Engineers (ASME) Code. The submittal proposed an alternative to selected requirements of the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1995 Edition, 1996 Addenda, Appendix VIII, Supplement 10, "Qualification Requirements for Dissimilar Metal Piping Welds."

The U.S. Nuclear Regulatory Commission staff has reviewed the request against the requirements of 10 CFR 50.55a(g)(6)(ii)(C) as related to the implementation of ASME Code, Section XI, Appendix VIII, Supplement 10. The results of this review are documented in the enclosed Safety Evaluation.

The staff has reviewed your request and, based on the information provided, concludes that the proposed alternative provides an acceptable level of quality and safety. Therefore, the proposed alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(i) for the second inservice inspection interval.

Sincerely,

/RA REnnis for/

Darrell Roberts, Acting Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-311

Enclosure: As stated

cc w/encl: See next page

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Salem Nuclear Generating Station, Unit No. 2

cc:

Mr. A. Christopher Bakken, III
Senior Vice President - Site Operations
PSEG Nuclear - X15
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. John T. Carlin
Vice President - Nuclear Assessments
PSEG Nuclear - N10
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. David F. Garchow
Vice President - Eng/Tech Support
PSEG Nuclear - N28
P.O. Box 236
Hancocks Bridge, NJ 08038

Mr. Gabor Salamon
Manager - Licensing
PSEG Nuclear - N21
P.O. Box 236
Hancocks Bridge, NJ 08038

Jeffrie J. Keenan, Esquire
PSEG Nuclear - N21
P.O. Box 236
Hancocks Bridge, NJ 08038

Ms. R. A. Kankus
Joint Owner Affairs
PECO Energy Company
Nuclear Group Headquarters KSA1-E
200 Exelon Way
Kennett Square, PA 19348

Lower Alloways Creek Township
c/o Mary O. Henderson, Clerk
Municipal Building, P.O. Box 157
Hancocks Bridge, NJ 08038

Dr. Jill Lipoti, Asst. Director
Radiation Protection Programs
NJ Department of Environmental
Protection and Energy
CN 415
Trenton, NJ 08625-0415

Brian Beam
Board of Public Utilities
2 Gateway Center, Tenth Floor
Newark, NJ 07102

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

Senior Resident Inspector
Salem Nuclear Generating Station
U.S. Nuclear Regulatory Commission
Drawer 0509
Hancocks Bridge, NJ 08038

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF S2-I2-RR-A16

SECOND 10-YEAR INSERVICE INSPECTION INTERVAL

SALEM NUCLEAR GENERATING STATION, UNIT NO. 2

PSEG NUCLEAR, LLC

DOCKET NO. 50-311

1.0 INTRODUCTION

By letter dated September 10, 2003, PSEG Nuclear, LLC (licensee) submitted Relief Request S2-I2-RR-A16 for the Salem Nuclear Generating Station, Unit No. 2 (Salem 2). The submittal requested relief from selected requirements of the American Society of Mechanical Engineers (ASME) Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 1995 Edition, 1996 Addenda, Appendix VIII, Supplement 10, "Qualification Requirements for Dissimilar Metal Piping Welds."

The relief request would authorize the use of a proposed alternative program to the dissimilar metal welds ultrasonic examination requirements of ASME Code, Section XI, Appendix VII, Supplement 10, for the second inservice inspection (ISI) interval.

2.0 REGULATORY EVALUATION

In a final rulemaking on September 22, 1999 (64 FR 51370), the U.S. Nuclear Regulatory Commission (NRC or the Commission) imposed a requirement for expedited implementation of Appendix VIII to Section XI of the ASME Code. That appendix contains several supplements, which licensees were to implement on a phased basis over a three-year period, with Supplement 10 scheduled to be implemented by November 22, 2002. The NRC concluded that the expedited implementation of Appendix VIII was "... necessary to bring the facilities described into compliance with General Design Criterion 14, Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix A, or similar provisions in the licensing basis for these facilities, and Criterion II, 'Quality Assurance Program,' and Criterion XVI, 'Corrective Actions,' of Appendix B to 10 CFR Part 50" (64 FR 51394).

Prior to November 22, 2002, the requirements for conducting dissimilar metal weld qualifications and examinations using ultrasonic techniques were stipulated in Appendix III to Section XI of the ASME Code. Since that date, however, these requirements are stipulated in Appendix VIII to Section XI of the ASME Code. A significant difference between these appendices is that Appendix III consists of prescriptive-based criteria, while Appendix VIII consists of performance-based criteria. This is important because the performance-based criteria substantially improve the ability of an examiner to detect and characterize flaws during

ultrasonic examination of components and, thereby, provide for more reliable examination results.

In accordance with 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components must meet the requirements set forth in ASME Code, Section XI, “Rules for Inservice Inspection of Nuclear Power Plants Components” to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that all inservice examinations and system pressure tests conducted during the first 10-year interval, and subsequent intervals, comply with the requirements in the latest edition and addenda of ASME Code, Section XI, incorporated by reference in 10 CFR 50.55a(b) on the date 12 months prior to the start of the 10-year interval. For Salem 2, the 1986 Edition to ASME Code, Section XI, is the applicable edition for the current 10-year ISI interval.

In accordance with 10 CFR 50.55a(g)(6)(ii)(C), the implementation of Supplements 1 through 9, 10, 12, and 13 of Appendix VIII to Section XI, 1995 Edition with the 1996 Addenda of the ASME Code is required on a phased schedule ending on November 22, 2002. Supplement 10 was included in the last phase of implementation and was required to be implemented by November 22, 2002. Additionally, 10 CFR 50.55a(g)(6)(ii)(C)(2) requires licensees implementing the 1995 Edition, and the earlier edition of Section XI of the ASME Code and supplements, to implement the 1995 Edition with the 1996 Addenda of Appendix VIII and supplements to Appendix VIII of Section XI of the ASME Code.

Alternatives to requirements may be authorized or relief granted by the NRC pursuant to 10 CFR 50.55a(a)(3), 10 CFR 50.55a(f)(6)(i), or 10 CFR 50.55a(g)(6)(i). In proposing alternatives, the licensee must demonstrate that: (1) the proposed alternatives provide an acceptable level of quality and safety; (2) compliance with the requirements of 10 CFR 50.55a would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety; or (3) conformance is impractical for the facility. Pursuant to 10 CFR 50.55a(g)(4)(iv), ISI items may meet the requirements set forth in subsequent editions and addenda of the ASME Code that are incorporated by reference in 10 CFR 50.55a(b), subject to the limitations and modifications listed therein, and subject to Commission approval. Portions of editions and addenda may be used, provided that related requirements of the respective editions and addenda are met.

The licensee submitted the request pursuant to 10 CFR 50.55a(a)(3)(i), as a proposed alternative to the implementation of ASME Code Section XI, Appendix VIII, Supplement 10 for the second ISI interval.

3.0 TECHNICAL EVALUATION

3.1 Code Requirements for which Relief is Requested

The licensee requested relief from selected requirements of ASME Code, Section XI, Appendix VIII, Supplement 10 (1995 Edition with 1996 Addenda), the implementation of which is required in accordance with 10 CFR 50.55a(g)(6)(ii)(C).

The licensee proposed alternatives to the following Supplement 10 requirements:

1. Paragraph 1.1(b) states, in part: "Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent."

2. Paragraph 1.1(d) states: "All flaws in the specimen set shall be cracks."

3. Paragraph 1.1(d)(1) states: "At least 50% of the cracks shall be in austenitic material. At least 50% of the cracks in austenitic material shall be contained wholly in weld or buttering material. At least 10% of the cracks shall be in ferritic material. The remainder of the cracks may be in either austenitic or ferritic material."

4. Paragraph 1.2(b) states, in part: "The number of unflawed grading units shall be at least twice the number of flawed grading units."

5. Paragraph 1.2(c)(1) and 1.3(c) state, in part: "At least 1/3 of the flaws, rounded to the next higher whole number, shall have depths between 10% and 30% of the nominal pipe wall thickness. Paragraph 1.4(b) distribution table requires 20% of the flaws to have depths between 10% and 30%."

6. Paragraph 2.0, first sentence states: "The specimen inside surface and identification shall be concealed from the candidate."

7. Paragraph 2.2(b) states, in part: "The regions containing a flaw to be sized shall be identified to the candidate."

8. Paragraph 2.2(c) states, in part: "For a separate length sizing test, the regions of each specimen containing a flaw to be sized shall be identified to the candidate."

9. Paragraph 2.3(a) states: "For the depth sizing test, 80% of the flaws shall be sized at a specific location on the surface of the specimen identified to the candidate."

10. Paragraph 2.3(b) states: "For the remaining flaws, the regions of each specimen containing a flaw to be sized shall be identified to the candidate. The candidate shall determine the maximum depth of the flaw in each region."

11. Table VIII-S2-1 provides the false call criteria when the number of unflawed grading units is at least twice the number of flawed grading units.

3.1.1 System/Component(s) for which Relief is Requested

The requested relief applies to dissimilar metal piping welds subject to examination using procedures, personnel and equipment qualified to ASME XI, Appendix VIII, Supplement 10 criteria.

3.2 Licensee's Proposed Alternative and Bases

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee proposed the following for the second ISI interval. The proposed alternative would be implemented through the Electric Power Research Institute (EPRI), Performance Initiative Program (PDI).

Paragraph 1.1(b) proposed alternative:

> The specimen set shall include the minimum and maximum pipe diameters and thicknesses for which the examination procedure is applicable. Pipe diameters within a range of ½ in. (13 mm) of the nominal diameter shall be considered equivalent. Pipe diameters larger than 24 in. (610 mm) shall be considered to be flat. When a range of thicknesses is to be examined, a thickness tolerance of +25% is acceptable.
>
> Technical Basis - The change in the minimum pipe diameter tolerance from 0.9 times the diameter to the nominal diameter minus 0.5 inch provides tolerances more in line with industry practice. Though the alternative is less stringent for small pipe diameters, they typically have a thinner wall thickness than larger diameter piping. A thinner wall thickness results in shorter sound path distances that reduce the detrimental effects of the curvature. This change maintains consistency between Supplement 10 and the recent revision to Supplement 2.

Paragraph 1.1 (d) proposed alternative:

> At least 60% of the flaws shall be cracks, the remainder shall be alternative flaws. Specimens with IGSCC [intergranular stress corrosion cracking] shall be used when available. Alternative flaws, if used, shall provide crack-like reflective characteristics and shall be limited to the case where implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws. Alternative flaw mechanisms shall have a tip width of less than or equal to 0.002 in. (0.05 mm).
>
> Technical Basis - As illustrated below, implanting a crack requires excavation of the base material on at least one side of the flaw. While this may be satisfactory for ferritic materials, it does not produce a useable axial flaw in austenitic materials because the sound beam, which normally passes only through base material, must now travel through weld material on at least one side, producing an unrealistic flaw response. In addition, it is important to preserve the dendritic structure present in field welds that would otherwise be destroyed by the implantation process. To resolve these issues, the proposed alternative allows the use of up to 40% fabricated flaws as an alternative flaw mechanism under controlled conditions. The fabricated flaws are isostatically compressed which produces ultrasonic reflective characteristics similar to tight cracks. Note: To avoid confusion the proposed alternative modifies instances of the term "cracks" or "cracking" to the term "flaws" because of the use of alternative flaw mechanisms.

Paragraph 1.1(d)(1) alternative:

At least 80% of the flaws shall be contained wholly in weld or buttering material. At least one and a maximum of 10% of the flaws shall be in ferritic base material. At least one and a maximum of 10% of the flaws shall be in austenitic base material.

Technical Basis - Under the current Code, as few as 25% of the flaws are contained in austenitic weld or buttering material. The metallurgical structure of austenitic weld material is ultrasonically more challenging than either ferritic or austenitic base material. The proposed alternative is, therefore, more challenging than the current Code.

Paragraph 1.2(b) alternative:

Detection sets shall be selected from Table VIII-S10-1. The number of unflawed grading units shall be at least one and a half times the number of flawed grading units.

Technical Basis - [New] Table [VIII-]S10-1 provides a statistically based ratio between the number of unflawed grading units and the number of flawed grading units. The proposed alternative reduces the ratio to 1.5 times to reduce the number of test samples to a more reasonable number from the human factors perspective. However, the statistical basis used for screening personnel and procedures is still maintained at the same level with competent personnel being successful and less skilled personnel being unsuccessful. The acceptance criteria for the statistical basis are in Table VIII-S10-1.

Paragraph 1.2(c)(1) and 1.3(c) alternative:

The proposed alternative to the flaw distribution requirements of Paragraphs 1.2(c)(1) (detection) and 1.3(c) (length) is to use the Paragraph 1.4(b) (depth) distribution table (below) for all qualifications.

Flaw Depth (% Wall Thickness)	**Minimum Number of Flaws**
10-30%	20%
31-60%	20%
61-100%	20%

In addition, the proposed alternative includes the following: "At least 75% of the flaws shall be in the range of 10 to 60% of wall thickness."

Technical Basis - The proposed alternative uses the depth sizing distribution for both detection and depth sizing because it provides for a better distribution of flaw sizes within the test set. This distribution allows candidates to perform detection, length, and depth sizing demonstrations simultaneously utilizing the same test set. The requirement that at least 75% of the flaws shall be in the range of 10 to 60% of wall thickness provides an overall distribution tolerance yet the distribution uncertainty decreases the

possibilities for testmanship [sic] that would be inherent to a uniform distribution. It must be noted that it is possible to achieve the same distribution utilizing the present requirements, but it is preferable to make the criteria consistent.

Paragraph 2.0, first sentence alternative:

For qualifications from the outside surface, the specimen inside surface and identification shall be concealed from the candidate. When qualifications are performed from the inside surface, the flaw location and specimen identification shall be obscured to maintain a "blind test".

Technical Basis - The current Code requires that the inside surface be concealed from the candidate. This makes qualifications conducted from the inside of the pipe (e.g., PWR [pressurized water reactor] nozzle to safe end welds) impractical. The proposed alternative differentiates between ID [inside diameter] and OD [outside diameter] scanning surfaces, requires that they be conducted separately, and requires that flaws be concealed from the candidate. This is consistent with the recent revision to Supplement 2.

Paragraphs 2.2(b) and 2.2(c) first sentence alternative:

"... containing a flaw to be sized may be identified to the candidate."

Technical Basis - The current Code requires that the regions of each specimen containing a flaw to be length sized shall be identified to the candidate. The candidate shall determine the length of the flaw in each region (Note, that length and depth sizing use the term "regions" while detection uses the term "grading units" - the two terms define different concepts and are not intended to be equal or interchangeable). To ensure security of the samples, the proposed alternative modifies the first "shall" to a "may" to allow the test administrator the option of not identifying specifically where a flaw is located. This is consistent with the recent revision to Supplement 2.

Paragraphs 2.3(a) and 2.3(b) alternative:

"... regions of each specimen containing a flaw to be sized may be identified to the candidate."

Technical Basis - The current Code requires that a large number of flaws be sized at a specific location. The proposed alternative changes the "shall" to a "may" which modifies this from a specific area to a more generalized region to ensure security of samples. This is consistent with the recent revision to Supplement 2. It also incorporates terminology from length sizing for additional clarity.

Paragraph 3.1 alternative:

The proposed alternative modifies the acceptance criteria at Table VIII-S2-I and replaces Table VIII-SI0-I.

TABLE VIII-S10-1
PERFORMANCE DEMONSTRATION DETECTION TEST
ACCEPTANCE CRITERIA

Detection Test Acceptance Criteria		False Call Test Acceptance Criteria	
No. of Unflawed Grading Units	Minimum Detection Criteria	No. of Unflawed Grading Units	Maximum Number of False Calls
~~5~~	~~5~~	~~10~~	~~0~~
~~6~~	~~6~~	~~12~~	~~1~~
~~7~~	~~6~~	~~14~~	~~1~~
~~8~~	~~7~~	~~16~~	~~2~~
~~9~~	~~7~~	~~18~~	~~2~~
10	8	~~20~~ 15	~~3~~ 2
11	9	~~22~~ 17	~~3~~ 3
12	9	~~24~~ 18	~~3~~ 3
13	10	~~26~~ 20	~~4~~ 3
14	10	~~28~~ 21	~~5~~ 3
15	11	~~30~~ 23	~~5~~ 3
16	12	~~32~~ 24	~~6~~ 4
17	12	~~34~~ 26	~~6~~ 4
18	13	~~36~~ 27	~~7~~ 4
19	13	~~38~~ 29	~~7~~ 4
20	14	~~40~~ 30	~~8~~ 5

Technical Basis - The proposed alternative is identified as a new Table [VIII-]S10-1. It was modified to reflect the reduced number of unflawed grading units and allowable false calls. As a part of ongoing Code activities, Pacific Northwest National Laboratory (PNNL) has reviewed the statistical significance of these revisions and offered the revised Table [VIII-]S10-1.

3.3 Evaluation of Licensees' Proposed Alternatives

Paragraph 1.1(b)

The ASME Code requirement of "0.9 to 1.5 times the nominal diameter are equivalent" was established for a single nominal diameter. When applying the Code-required tolerance to a range of diameters, the tolerance rapidly expands on the high side. Under the current code requirements, a five-inch OD pipe would be equivalent to a range of 4.5-inch to 7.5-inch diameter pipe. Under the proposed PDI guidelines, the equivalent range would be reduced to 4.5-inch to 5.5-inch diameter pipe. With current Code requirements, a 16-inch nominal

diameter pipe would be equivalent to a range of a 14.4-inch to 24-inch diameter pipe. The proposed alternative would reduce the tolerance for a 16-inch diameter pipe to the equivalent range of 15.5-inch to a 16.5-inch diameter pipe. The difference between Code and the proposed alternative for diameters less than five inches is not significant because of shorter metal path and beam spread associated with smaller diameter piping.

The staff reviewed the licensee's technical basis for the proposed alternative and agrees with the licensee's assessment that the alternative provides tolerances more in line with industry practice. Based on the previous discussion, the staff finds the proposed alternative will provide more conservative tolerance results for a range of piping diameters in comparison to the current ASME Code requirements. The staff also finds that the differences in tolerance results for smaller diameter piping are not significant. Therefore, the staff finds the proposed alternative acceptable.

Paragraph 1.1 (d)

The ASME Code requires all flaws to be cracks. Creating test specimens containing cracks free of spurious reflections and telltale indicators is extremely difficult in austenitic material. To overcome these difficulties, EPRI developed a process for fabricating flaws that produce ultrasonic testing acoustic responses similar to the responses associated with real cracks. EPRI presented its process for discussion at public meetings held June 12 through 14, 2001 and January 31 through February 2, 2002 at the EPRI NDE Center, Charlotte, North Carolina.

The staff attended the meetings and, based on engineering judgement, determined that the process parameters used for manufacturing fabricated flaws demonstrated the ability to produce acoustic responses similar to those associated with actual cracks. In addition, the staff reviewed the licensee's technical basis and agrees with the licensee's assessment. Therefore, the staff concludes that the proposed alternative adequately demonstrates that ASME Code requirements are met.

Paragraph 1.1(d)(1)

The ASME Code requires that at least 50% of the flaws be contained in austenitic material, and 50% of the flaws in the austenitic material shall be contained fully in weld or buttering material. This means that at least 25% of the total flaws must be located in the weld or buttering material. Field experience shows that flaws identified during ISI of dissimilar metal welds are more likely to be located in the weld or buttering material. The grain structure of austenitic weld and buttering material represents a much more stringent ultrasonic scenario than that of a ferritic material or austenitic base material. Flaws in austenitic base material are difficult to create free of spurious reflectors and telltale indicators.

The staff finds the proposed alternative provides a testing scenario reflective of industry experience, and minimizes difficulties associated with telltale reflectors common to placing flaws in austenitic base material. Therefore, the staff finds the proposed alternative provides a more rigorous inspection than that required by the ASME Code and is, therefore, acceptable.

Paragraph 1.2(b)

The Code requires that detection sets meet the requirements of Table VIII-S2-1, which specifies the minimum number of flaws in a test set to be five with 100% detection. The current Code also requires the number of unflawed grading units to be two times the number of flawed grading units. The proposed alternative would follow the detection criteria of the table beginning with a minimum number of flaws in a test set being 10, and reducing the number of false calls to one and a half times the number of flawed grading units.

The staff reviewed the licensee's technical basis and finds that the proposed alternative satisfies the pass/fail objective established in ASME Code, Section XI, Appendix VIII for performance demonstration acceptance criteria.

Paragraphs 1.2(c)(1) and 1.3(c)

For detection and length sizing, the ASME Code requires at least 1/3 of the flaws be located between 10 and 30% through the wall thickness and 1/3 located greater than 30% through the wall thickness. The remaining 40% would be located randomly throughout the wall thickness. The proposed alternative sets the distribution criteria for detection and length sizing to be the same as the depth sizing distribution, which stipulates that at least 20% of the flaws be located in each of the increments of 10-30%, 31-60% and 61-100%. The remaining 40% would be located randomly throughout the wall thickness. With the exception of the 10-30% increment, the proposed alternative is a subset of the current Code requirements. The 10-30% increment would be in the subset if it contained at least 30% of the flaws.

The staff reviewed the licensee's technical basis for the proposed alternative. The staff finds the change simplifies the assembly of test sets for detection and sizing qualifications and is more indicative of actual conditions in the field. In addition, the staff finds the proposed alternative does not significantly deviate from, or reduce the level of, detection and length sizing from that required in the ASME Code. Therefore, the staff finds the alternative is acceptable.

Paragraph 2.0

The ASME Code requires the specimen inside surface be concealed from the candidate. This requirement is applicable for test specimens used for qualification performed from the outside surface. With the expansion of Supplement 10 to include qualifications performed from the inside surface, the inside surface must be accessible while maintaining the specimen integrity. The proposed alternative requires that flaws and specimen identifications be obscured from candidates, thus maintaining blind test conditions. The staff finds this to be appropriate, and therefore, acceptable.

Paragraphs 2.2(b) and 2.2(c)

The ASME Code requires that the location of flaws added to the test set for length sizing shall be identified to the candidate. The proposed alternative is to make identifying the location of additional flaws an option.

This option provides an additional element of difficulty to the testing process because the candidate would be expected to demonstrate the skill of detecting and sizing flaws over an area

larger than a specific location. The staff finds the alternative, if utilized, would require the demonstration of a higher level of skill than that currently required by the ASME Code and is, therefore, acceptable.

Paragraph 2.3(a)

The ASME Code requires that 80% of the flaws be sized in a specific location that is identified to the candidate. The proposed alternative permits detection and depth sizing to be conducted separately or concurrently. In order to maintain a blind test, the location of flaws cannot be shared with the candidate. For depth sizing that is conducted separately, allowing the test administrator the option of not identifying flaw locations makes the testing process more challenging.

The staff finds that the proposed alternative will provide an additional element of difficulty to the testing process since the candidate would be expected to demonstrate the skill of detecting and sizing flaws in an unknown location. The staff finds the alternative, if utilized, would require the demonstration of a higher level of skill than that currently required by the ASME Code and is, therefore, acceptable.

Paragraph 2.3(b)

The ASME Code requires that the location of flaws added to the test set for depth sizing shall be identified to the candidate. The proposed alternative is to make identifying the location of additional flaws an option.

This option provides an additional element of difficulty to the testing process because the candidate would be expected to demonstrate the skill of finding and sizing flaw's in an area larger than a specific location. The staff finds the alternative, if utilized, would require the demonstration of a higher level of skill than that currently required by the ASME Code and is, therefore, acceptable.

Paragraph 3.1 (Table VIII-S10-1)

The ASME Code requirements, discussed in Paragraph 1.2(b) above, are based on statistical parameters for screening personnel. The proposed alternative increases the minimum number of flawed grading units and reduces the number of unflawed grading units while maintaining the same statistical parameters as Code.

The staff finds this acceptable because the same pass/fail criteria used to develop the test size tables in Appendix VIII were used to create the PDI alternative Supplement 10, Table VIII-S10-1. The staff finds that the alternative does not significantly impact the false call criteria established in the Table and is, therefore, acceptable.

4.0 CONCLUSION

The staff has reviewed the licensee's submittal and determined that, in accordance with 10 CFR 50.55a(a)(3)(i), the proposed alternative program will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the staff authorized the proposed alternative for the second ISI interval. All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: G. Wunder

Date: December 29, 2003