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U. S. Nuclear Regulatory Commission
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BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324/LICENSE NOS. DPR-71 AND DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
REGARDING REQUEST FOR APPROVAL OF RELIEF REQUEST FOR
REACTOR PRESSURE VESSEL NOZZLE INNER RADIUS VOLUMETRIC
EXAMINATIONS (NRC TAC NOS. MB5854 AND MB5855)

Ladies and Gentlemen:

On July 16, 2002 (Serial: BSEP 02-0116), Carolina Power & Light (CP&L) Company requested approval of two 10-year Inservice Inspection Program relief requests for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2. As an alternative to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, requirements for the performance of volumetric examinations of reactor pressure vessel nozzle inner radii, CP&L proposed the use of enhanced visual examinations. Subsequently, on November 7, 2002, the NRC provided an electronic version of a Request for Additional Information (RAI) requesting information on the enhanced visual examination, flaw characterization, and the planned use of direct versus remote visual examinations. The responses to these questions are provided in Enclosure 1. Updated versions of the two previously submitted relief requests are provided in Enclosures 2 and 3.

Please refer any questions regarding this submittal to Mr. Leonard R. Beller, Supervisor - Licensing/Regulatory Programs, at (910) 457-2073.

Sincerely,

Edward T. O'Neil
Manager - Support Services
Brunswick Steam Electric Plant

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WRM/wrm

Enclosures:

1. Response to Request for Additional Information
2. Relief Request RR-29, Revision 1, "RPV Nozzle Inner Radius Volumetric Examinations"
3. Relief Request RR-30, Revision 1, "RPV Nozzle Inner Radius Volumetric Examinations"

cc (with enclosures):

U. S. Nuclear Regulatory Commission, Region II
ATTN: Mr. Luis A. Reyes, Regional Administrator
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW, Suite 23T85
Atlanta, GA 30303-8931

U. S. Nuclear Regulatory Commission
ATTN: Mr. Theodore A. Easlick, NRC Senior Resident Inspector
8470 River Road
Southport, NC 28461-8869

U. S. Nuclear Regulatory Commission
ATTN: Ms. Brenda L. Mozafari (Mail Stop OWFN 8G9) **(Electronic Copy Only)**
11555 Rockville Pike
Rockville, MD 20852-2738

U. S. Nuclear Regulatory Commission
ATTN: Mr. Leonard N. Olshan (Mail Stop OWFN 8H12) **(Electronic Copy Only)**
11555 Rockville Pike
Rockville, MD 20852-2738

U. S. Nuclear Regulatory Commission
ATTN: Mr. Allen G. Howe (Mail Stop OWFN 8G9) **(Electronic Copy Only)**
11555 Rockville Pike
Rockville, MD 20852-2738

Ms. Jo A. Sanford
Chair - North Carolina Utilities Commission
P.O. Box 29510
Raleigh, NC 27626-0510

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Division of Boiler and Pressure Vessel
North Carolina Department of Labor
ATTN: Mr. Jack Given, Assistant Director of Boiler & Pressure Vessels
4 West Edenton Street
Raleigh, NC 27601-1092

Response to Request for Additional Information

Background

On July 16, 2002 (Serial: BSEP 02-0116), Carolina Power & Light (CP&L) Company requested approval of two 10-year Inservice Inspection Program relief requests for the Brunswick Steam Electric Plant (BSEP), Units 1 and 2. As an alternative to American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, requirements for the performance of volumetric examinations of reactor pressure vessel nozzle inner radii, CP&L proposed the use of enhanced visual examinations. Subsequently, on November 7, 2002, the NRC provided an electronic version of a Request for Additional Information (RAI) requesting information on the enhanced visual examination, flaw characterization, and the planned use of direct versus remote visual examinations. The responses to these questions follow. Updated versions of the two previously submitted relief requests are provided in Enclosures 2 and 3. These relief requests have been revised to clarify that the 1/2 mil wire standard described in the Electric Power Research Institute (EPRI) technical report entitled *TR-105696-R4 (BWRVIP-03) Revision 4: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines*, will be used to conduct the enhanced visual examinations rather than the 1 mil wire standard previously cited in the relief requests.

NRC Request 2.1:

General Information: Please state the start and end dates for the Brunswick 1-2 third 10-year ISI interval.

CP&L Response:

The third in-service inspection interval for BSEP, Units 1 and 2, began on May 11, 1998, and will end on May 10, 2008.

NRC Request 2.2:

Enhanced Visual Examination: For both RR-29 and RR-30, the licensee is requesting to use a remote enhanced visual examination (EVT) in lieu of the Code-required volumetric examination for inner radius sections of several reactor pressure vessel (RPV) nozzles. The remote EVT would be conducted from the inside of the vessel by guiding an underwater camera to the subject nozzle areas. Use of a 1-mil (0.001-inch) diameter wire standard is to be used to show sensitivity for detection of flaws on the inside surface of the inner radius sections. Please provide the following information.

- 1) Describe how the 1-mil wire standard will be deployed during the EVT. For instance, will the standard be attached to the camera fixture so that

sensitivity can be established through-out the examination, or simply used at the beginning and end of each examination? In addition, will the ability of the visual system to detect the 1-mil wire be verified for a range of distances and lighting, and will all conditions in the RPV be simulated during this "calibration"?

- 2) Confirm that all applicable requirements for visual VT-1 examination, as specified in the 1989 Edition of ASME, will be met during the EVT, with the exception of using the 1-mil standard versus a neutral gray card with a 1/32-inch black line.
- 3) Describe the magnification capabilities of the remote visual system, and its capabilities for measuring the lengths of any flaws detected.
- 4) Confirm that the surfaces of the nozzle inner radius sections will be clean and free of any conditions that may impair the capabilities of the EVT to detect cracking that is open to the surface of the component.

CP&L Response:

Part 1:

The nozzle inner radius remote visual inspections will be performed using a site-specific procedure that incorporates the Enhanced VT-1 (EVT-1) requirements described in the EPRI technical report entitled *TR-105696-R4 (BWRVIP-03) Revision 4: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines*. The Enhanced VT-1 described in this report is a visual inspection method with equipment and environmental conditions such that the inspection can achieve a 1/2 mil resolution.

The resolution check will be performed prior to, and at the completion of, each examination or series of examinations. The lens-to-object distance and lighting required to discern the wire will be at the maximum distance that will be used during the examination.

The procedure to be used also addresses lens-to-object distances, adequacy of lighting, water clarity, and surface cleanliness. These attributes are determined by the level of detail to which the following conditions can be seen:

- Grinding/machine marks
- Undercut
- Weld ripples/beads
- Pre-existing indications

In addition, independent reviews are performed by CP&L, vendor, and Authored Nuclear Inservice Inspectors (ANII) personnel to ensure procedural requirements are met.

Part 2:

As stated above, the nozzle inner radius remote visual inspections will be performed using a site-specific procedure that incorporates the applicable Enhanced VT-1 (EVT-1) requirements described in the Electric Power Research Institute (EPRI) technical report entitled *TR-105696-R4 (BWRVIP-03) Revision 4: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines*. This procedure also meets the requirements of the 1989 edition of the ASME Code, Section XI.

Part 3:

The inspection system is capable of magnification; however, there is no minimum magnification capability required by the EVT-1 procedure. Adequate resolution is determined using a 1/2 mil wire. Flaw lengths will be measured using any means that can be demonstrated under actual conditions to have repeatable accuracy (e.g., a ruler on a pole, ultrasonic testing). It should be noted that the 1989 edition of the ASME Code, Section XI, Table IWB-3512-1, does not require flaw length determination for inside corner regions (i.e., for the nozzle inner radius inspections). This is also discussed in the response to NRC Request 2.3.

Part 4:

The EVT-1 inspection procedure requires that the surfaces be free from any conditions that would prevent detection of the smallest expected anomaly. The procedure also requires cleanliness to be discussed during a 4 hour indoctrination training session which is required for all inspection personnel. Cleaning methods, which have been used at Brunswick for previous shroud examinations, are also addressed in the procedure.

NRC Request 2.3:

Flaw Characterization and Disposition: The licensee states that "crack-like flaws exceeding the acceptance criteria of Table IWB-3512-1 will be deemed unacceptable for continued service unless the reactor vessel meets the requirements of IWB-3142.2, IWB-3142.3, or IWB-3142.4." It should be noted that the licensee is already committed to using the acceptance criteria in Paragraph IWB-3512, and the statement above provides no new commitments or alternatives.

- 1) Table IWB-3512-1 is intended to be used for volumetric examinations and requires the licensee to characterize both the length and depth of the crack. Describe how the licensee will characterize flaws detected during the EVT

so that an aspect ratio (a/l) may be applied for use with the Tables in IWB-3512.

CP&L Response:

Table IWB-3512-1 of the 1989 edition of the ASME Code, Section XI, provides limits for allowable planar flaws. Table IWB-3512-1 does not require flaw length determination for inside corner regions (i.e., for the nozzle inner radii, as shown in Figure IWB-2500-7(b)). Rather, only the a/t ratio, the flaw depth divided by the wall thickness, is required. Therefore, for the nozzle inner radius examinations, determination of an aspect (a/l) ratio is not required. If there is a need to measure length, the EVT method will be used. The through-wall dimension will be measured using a volumetric (i.e., ultrasonic examination) method.

NRC Request 2.4:

Direct Versus Remote Visual: For RRs 29 and 30, confirm that the EVT will be performed as a remote visual for all nozzle inside radius sections. If certain of the nozzles will be performed with a direct visual, list those.

CP&L Response:

Relief Requests RR-29 and RR-30 identify the specific reactor pressure vessel nozzles for which CP&L is requesting approval to use the remote visual EVT-1 inspection. None of the listed reactor vessel nozzles are accessible for direct visual examination. The remaining, unlisted reactor vessel nozzles have already been ultrasonically examined.

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324/LICENSE NOS. DPR-71 AND DPR-62
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
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REACTOR PRESSURE VESSEL NOZZLE INNER RADIUS
VOLUMETRIC EXAMINATIONS (NRC TAC NOS. MB5854 AND MB5855)

Relief Request RR-29, Revision 1,
"RPV Nozzle Inner Radius Volumetric Examinations"

RELIEF REQUEST: RR-29, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

COMPONENTS FOR WHICH RELIEF IS REQUESTED:

This relief request is applicable to the inner radius sections for the following Reactor Pressure Vessel (RPV) nozzles:

Nozzle N5A (Core Spray)
Nozzle N5B (Core Spray)
Nozzle N2A (Reactor Recirculation System Inlet)
Nozzle N2B (Reactor Recirculation System Inlet)
Nozzle N2C (Reactor Recirculation System Inlet)
Nozzle N2D (Reactor Recirculation System Inlet)
Nozzle N2E (Reactor Recirculation System Inlet)
Nozzle N2F (Reactor Recirculation System Inlet)
Nozzle N2G (Reactor Recirculation System Inlet)
Nozzle N2H (Reactor Recirculation System Inlet)
Nozzle N2J (Reactor Recirculation System Inlet)
Nozzle N2K (Reactor Recirculation System Inlet)
Nozzle N8A (Jet Pump Instrumentation)
Nozzle N8B (Jet Pump Instrumentation)

ASME SECTION XI CODE REQUIREMENT:

The American Society of Mechanical Engineers (ASME) Code, Section XI, 1989 Edition, Table IWB-2500-1 for Examination Category B-D, requires a volumetric examination of the inner radius section of all RPV nozzles welded with full penetration welds as shown in Figures IWB-2500-7(a) through (d).

REQUESTED RELIEF:

In accordance with 10 CFR 50.55a(a)(3)(ii), Carolina Power & Light (CP&L) Company is requesting relief from the ASME Code, Section XI requirements to perform the volumetric examination described below.

PROPOSED ALTERNATIVE:

CP&L will perform a remote visual examination of the accessible surface M-N, as shown in Figures IWB-2500-7(a) through (d), in lieu of the volumetric examinations required by Table IWB-2500-1, Examination Category B-D, Item B3.100, for the RPV nozzles identified in this relief request. The remote visual examination will be performed using the Enhanced VT-1 (i.e., EVT-1) requirements described in the Electric Power Research Institute (EPRI) technical report entitled *TR-105696-R4 (BWRVIP-03) Revision 4: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination*

RELIEF REQUEST: RR-29, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

Guidelines. The resolution sensitivity for remote in-vessel examinations will be established using the 1/2 mil wire standard described in that report.

Crack-like surface flaws exceeding the acceptance criteria of Table IWB-3512-1 will be deemed unacceptable for continued service unless the reactor vessel meets the requirements of IWB-3142.2, IWB-3142.3, or IWB-3142.4.

This alternative is similar to the inspection alternative proposed in ASME Section XI Code Case N-648.

BASIS FOR REQUESTING RELIEF:

The volumetric examinations required by the ASME Code, Section XI will result in hardship without a compensating increase in the level of quality and safety, and the proposed visual examination alternative provides reasonable assurance of structural integrity of the subject components for the following reasons:

- Performance of the volumetric examinations results in significant personnel radiation exposure without a commensurate increase in the level of plant quality or safety. Volumetric examination requires the examiner to enter and remain inside the biological shield penetration area around the nozzle for the duration of the ultrasonic examination, which takes approximately one hour. Dose rates in the area for the specified nozzles, with shielding in place, are in the range of approximately 180 to 200 mr/hr. Performance of these examinations results in an estimated personnel exposure of approximately 3 rem per inspection interval. Visual examination will reduce personnel radiation exposure consistent with the plant ALARA Program.
- Visual examination of the inner radius region of the specified nozzles is limited because the reactor internal piping configuration prevents placement of the camera in all positions necessary to examine surface M-N over the full circumference (i.e., see Figure 1 below).

RELIEF REQUEST: RR-29, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

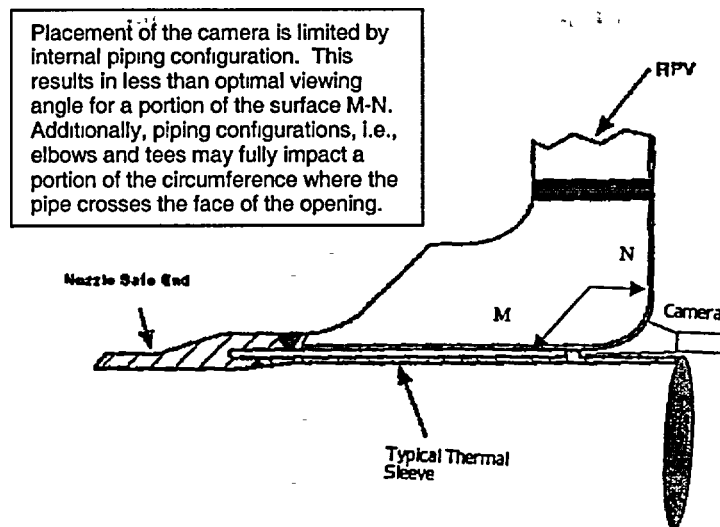


Figure 1
Typical Cross Section of BWR Nozzle with Internal Piping

The specific nozzle limitations and estimated coverage are as follows:

Nozzle Type/Number	Limitation	Estimated Coverage
Core Spray(2 nozzles)	Thermal Sleeve and Sparger	40%
Reactor Recirculation Inlet (10 nozzles)	Thermal Sleeve/Jet Pump Riser	50%
Jet Pump Instrumentation(2 nozzles)	Instrumentation Lines	60%

The limited visual examination does not significantly reduce the level of plant quality and safety for the following reasons:

- There are no mechanisms of damage, other than fatigue, for the nozzle inner radius and, other than feedwater nozzles, there is no cause for significant thermal cycling. Therefore, the primary flaw of concern would be a flaw that was not detected during the manufacturing process¹. For the Brunswick Steam Electric Plant (BSEP), the nozzles were examined during and after manufacturing by surface and volumetric techniques. Additionally, preservice

¹ Conclusions made in ASME NDE Subcommittee Report ISI-99-26, "Technical Basis for the Elimination of Reactor Vessel Nozzle Inner Radius Inspections."

RELIEF REQUEST: RR-29, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

and inservice ultrasonic examinations have detected no flaws. It is unlikely that flaws will be initiated by the fatigue mechanism.

- After approximately 25 years of operation (i.e., over 1000 reactor years of industry experience), no cracking of any kind in the subject nozzle inner radius regions has ever been found.
- Fracture toughness tests performed at Oak Ridge National Laboratories indicate there is a large flaw tolerance for boiling water reactor (BWR) nozzle inner radius regions. Even if flaw propagation was assumed, test results indicate a leak before break scenario would occur which would not result in a significant increase in core damage frequency.¹ Additionally, pressure testing continues to be performed each refueling outage, and during plant operation, containment is monitored for changes in unidentified leakage.
- More than 50 percent of the total nozzle population receives a complete nozzle inner radius examination and 40 percent of the total nozzle population has already received a volumetric examination during the current interval.
- Visual examination of the accessible nozzle inner radius surface (i.e., zone M-N) provides reasonable assurance that deep flaws are not present. Additionally, when flaws are initiated by the fatigue mechanism, they are typically encountered over a significant portion of the nozzle circumference as was the case for cracking of feedwater nozzles addressed in NUREG-0619.

In summary, fatigue cracking is the only applicable degradation mechanism for the nozzle inner radius region and for all nozzles other than feedwater nozzles. There is no significant thermal cycling of these nozzles during operation. Therefore, from a risk perspective, only volumetric examinations of the feedwater nozzles and operational control rod drive (CRD) return line nozzles are necessary. CRD nozzles at BSEP, Units 1 and 2 are cut and capped. This is supported by the fact that no service-related cracking has been discovered in any of the BWR fleet plant nozzles other than on feedwater or operational CRD return lines. The four (i.e., per unit) feedwater nozzles inner radius sections will continue to be examined with ultrasonic techniques developed and qualified in accordance with Topical Report GE-NE-523-A71-0594-A, Revision 1.

Additionally, Relief Request RR-30 provides for a full visual examination coverage (i.e., greater than 90 percent examination coverage, as defined by NRC Information Notice 98-42, "Implementation of 10 CFR 50.55a(g) Inservice Inspection Requirements") of ten additional nozzles resulting in complete examination of more than 50 percent of the total nozzle population. CP&L

¹ Conclusions made in ASME NDE Subcommittee Report ISI-99-26, "Technical Basis for the Elimination of Reactor Vessel Nozzle Inner Radius Inspections."

RELIEF REQUEST: RR-29, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

believes that the partial visual examination alternative for the nozzle inner radius regions above results in a significant reduction in personnel dose and still ensures an acceptable level of quality and safety.

REFERENCES:

1. ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1989 Edition with no Addenda.
2. Conclusions made in ASME Non-Destructive Examination Subcommittee Report ISI-99-26, "Technical Basis for Elimination of Reactor Pressure Vessel Nozzle Inner Radius Inspections."
3. General Electric Topical Report GE-NE-523-A71-0594-A, Revision 1, "Alternate BWR Feedwater Nozzle Inspection Requirements."
4. CP&L Relief Request RR-30, "RPV Nozzle Inner Radius Volumetric Examinations."

ENCLOSURE 3

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 AND 50-324/LICENSE NOS. DPR-71 AND DPR-62
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Relief Request RR-30, Revision 1,
"RPV Nozzle Inner Radius Volumetric Examinations"

RELIEF REQUEST: RR-30, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

COMPONENTS FOR WHICH RELIEF IS REQUESTED:

This relief request is applicable to the inner radius sections for the following Reactor Pressure Vessel (RPV) Nozzles:

Nozzle N9 (Control Rod Drive Return Line Nozzle)
Nozzle N1A (Reactor Recirculation System Suction)
Nozzle N1B (Reactor Recirculation System Suction)
Nozzle N11A (Reactor Pressure Vessel Instrumentation)
Nozzle N11B (Reactor Pressure Vessel Instrumentation)
Nozzle N16A (Reactor Pressure Vessel Instrumentation)
Nozzle N16B (Reactor Pressure Vessel Instrumentation)

ASME SECTION XI CODE REQUIREMENT:

The American Society of Mechanical Engineers (ASME) Code, Section XI, 1989 Edition, Table IWB-2500-1 for Examination Category B-D, requires a volumetric examination of the inner radius section of all RPV nozzles welded with full penetration welds as shown in Figures IWB-2500-7(a) through (d).

REQUESTED RELIEF:

In accordance with 10 CFR 50.55a(a)(3)(i), Carolina Power & Light (CP&L) Company is requesting relief from ASME Code, Section XI requirements to perform the volumetric examination alternative described below by substituting a visual examination of the accessible surface M-N, as shown in Figures IWB-2500-7(a) through (d).

PROPOSED ALTERNATIVE:

CP&L will perform a remote visual examination of the accessible surface M-N, as shown in Figures IWB-2500-7(a) through (d), in lieu of the volumetric examinations required by Table IWB-2500-1, Examination Category B-D, Item B3.100, for the RPV nozzles identified in this relief request. The remote visual examination will be performed using the Enhanced VT-1 (i.e., EVT-1) requirements described in the Electric Power Research Institute (EPRI) technical report entitled *TR-105696-R4 (BWRVIP-03) Revision 4: BWR Vessel and Internals Project, Reactor Pressure Vessel and Internals Examination Guidelines*. Required coverage will include essentially 100 percent (i.e., greater than 90 percent examination coverage, as defined by NRC Information Notice 98-42, "Implementation of 10 CFR 50.55a(g) Inservice Inspection Requirements") of the surface M-N as shown in Figure IWB-2500-1. The resolution sensitivity for remote in-vessel examinations will be established using the 1/2 mil wire standard described in that report.

RELIEF REQUEST: RR-30, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

Crack-like surface flaws exceeding the acceptance criteria of Table IWB-3512-1 will be deemed unacceptable for continued service unless the reactor vessel meets the requirements of IWB-3142.2, IWB-3142.3 or IWB-3142.4.

This alternative is similar to the inspection alternative proposed in ASME Section XI Code Case N-648.

BASIS FOR REQUESTING RELIEF:

Performance of the volumetric examinations results in significant personnel radiation exposure without a commensurate increase in the level of plant quality or safety for the following reasons:

- The subject nozzle forgings were nondestructively examined using inservice ultrasonic techniques specific to the nozzle configuration. No indication of fabrication defects or service related cracking has been detected by these examinations.
- Nozzle inner radius examinations are the only non-welded area requiring examination on the RPV. This requirement was deterministically made early in the development of the ASME Code, Section XI, and applied to 100 percent of nozzles welded with full penetration welds. Fatigue cracking is the only applicable degradation mechanism for the nozzle inner radius region. Other than feedwater nozzles, there is no significant thermal cycling during operation. Therefore, from a risk perspective, there is no need to perform volumetric examination on any nozzles other than feedwater and operational control rod drive (CRD) return line nozzles. The BSEP, Unit 1 and 2 CRD return line nozzles are cut and capped. No service induced cracking has been discovered in any of the boiling water reactor (BWR) fleet plant nozzles other than on feedwater nozzles or operational CRD return line nozzles.
- The four feedwater (i.e., per unit) nozzle inner radius sections will continue to be examined with ultrasonic techniques developed and qualified in accordance with Topical Report GE-NE-523-A71-0594-A, Revision 1. The NRC has previously approved this topical report under TAC No. MA6787. Including the feedwater nozzles, 40 percent of the applicable nozzle inner radius sections have been ultrasonically examined during the current interval.
- The visual examination will cover the same inspection surface as specified for the volumetric examination.

RELIEF REQUEST: RR-30, Revision 1

SUBJECT: RPV Nozzle Inner Radius Volumetric Examinations

REFERENCES:

1. ASME Code, Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components, 1989 Edition with no Addenda.
2. Code Case N-648, "Alternate Requirements for Inner Radius Examinations of Class 1 Reactor Pressure Vessel Nozzles, Section XI, Division 1."
3. General Electric Topical Report GE-NE-523-A71-0594-A, Revision 1, "Alternate BWR Feedwater Nozzle inspection Requirements."
4. CP&L Relief Request RR-29, "RPV Nozzle Inner Radius Volumetric Examinations."