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CPSES-200701302
Log # TXX-07095

Ref. # 10 CFR 50.55a(3)(i)

August 22, 2007

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION DOCKET NO. 50-446
RELIEF REQUEST B-4 TO THE UNIT 2 INSERVICE INSPECTION (ISI) PROGRAM PLAN FROM THE 1998 EDITION OF ASME CODE, SECTION XI, THROUGH 2000 ADDENDA (INTERVAL START DATE - AUGUST 03, 2004, SECOND INTERVAL)

REFERENCE: TXX-06154 dated October 3, 2006, from Mike Blevins to the NRC

Dear Sir or Madam:

Pursuant to 10 CFR 50.55a(a)(3), TXU Generation Company LP (Luminant Power) hereby requests NRC approval of relief from applicable requirements of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, as identified in the attached relief request. This request is for Comanche Peak's Repair/Replacement program, as established by the ASME Section XI Code, and involves utilization of an alternate approach to ASME Section XI requirements for a particular application.

Approval of this relief request will allow application of full structural weld overlays for nozzle-to-safe end dissimilar metal and safe end-to-piping stainless steel butt welds associated with the Comanche Peak Unit 2 pressurizer and connected piping. The overlays are a pre-emptive measure for addressing primary water stress corrosion cracking concerns that have been identified by the industry for welds associated with Alloy 600/82/182 components exposed to pressurized water reactor primary coolant. The proposed alternative requirements to be implemented have been determined to be appropriate for application and examination of the needed overlays, and will provide an acceptable level of quality and safety as required by 10 CFR 50.55a(a)(3)(i).

Comanche Peak Unit 1 requested a similar relief request (see referenced letter) which was implemented during the 12th refueling outage for Unit 1 in the Spring of 2007.

This communication contains one new licensing basis commitment regarding Comanche Peak Unit 2 and is described below.

A047
NRR

Commitment Number	Commitment Description
27466	A summary of results will be submitted within 14 days from completion of the last ultrasonic examination of the weld overlays for Comanche Peak Unit 2.

The commitment number is used by Luminant Power for the internal tracking of Comanche Peak commitments.

Luminant Power requests approval of this relief request by February 15, 2008. The approval date was selected to allow time to update procedures prior to the 10th refueling outage for Unit 2, scheduled for the Spring 2008. If you have any questions or need additional information regarding this matter, please feel free to contact Jack Hicks at (254) 897-6725.

Sincerely,

TXU Generation Company LP

By: TXU Generation Management Company LLC,
Its General Partner

Mike Blevins

By: _____
Fred W. Madden
Director, Oversight & Regulatory Affairs

Attachment

c - B. S. Mallett, Region IV
B. K. Singal, NRR
Resident Inspectors, Comanche Peak
T. Parks, Chief Inspector, TDLR

ATTACHMENT
10 CFR 50.55a AUTHORIZATION REQUEST
Comanche Peak Unit 2

Proposed Alternative
In Accordance With 10 CFR 50.55a(a)(3)(i)

10 CFR 50.55a RELIEF REQUEST

1.0 ASME CODE COMPONENTS AFFECTED

Component Numbers: (Pressurizer Vessel)

Comanche Peak Unit 2

Weld Numbers:	Components
TCX-1-4506-22	(4" spray nozzle-to-safe end weld)
TCX-1-4506-21	(4" spray safe end-to-piping weld)
TCX-1-4501-1	(6" safety "1" nozzle-to-safe end weld)
TCX-1-4501-2	(6" safety "1" safe end-to-piping weld)
TCX-1-4502-1	(6" safety "2" nozzle-to-safe end weld)
TCX-1-4502-2	(6" safety "2" safe end-to-piping weld)
TCX-1-4503-1	(6" safety "3" nozzle-to-safe end weld)
TCX-1-4503-2	(6" safety "3" safe end-to-piping weld)
TCX-1-4504-1	(6" relief nozzle-to-safe end weld)
TCX-1-4504-2	(6" relief safe end-to-piping weld)
TCX-1-4500-6	(14" surge nozzle-to-safe end weld)
TCX-1-4500-5	(14" surge safe end-to-piping weld)

Code Class: Class 1
Examination Categories: B-F
Item Number: B5.40
Description: Alternative Welded Repair for the Pressurizer Safety, Relief, Spray, and Surge Nozzle-to-safe end welds
References: ASME Section XI, 1998 Edition through the 2000 Addenda
ASME Section XI, 1995, 1996 Addenda
ASME Section XI, 2005 Addenda, Nonmandatory Appendix Q
ASME Section XI, Code Case N-504-2
ASME Section XI, Code Case N-638-1
ASME Section III, 1971 Edition through Summer 1973 Addenda
ASME Section III, 1974 Edition through Summer 1974 Addenda
ASME Section III, 1977 Edition through Summer 1979 Addenda

2.0 APPLICABLE CODE EDITION AND ADDENDA

ASME Section XI, 1998 Edition through the 2000 Addenda

3.0 APPLICABLE CODE REQUIREMENTS

IWA-4420 and IWA-4520(a) of ASME Section XI require repair/replacement activities to be performed and examined in accordance with the Owner's Requirements and the original Construction Code of the component or system. IWA-4430 and IWA-4600 provide for alternative welding methods when the requirements of IWA-4420 cannot be met. Table IWB-2500-1 Categories B-F and B-J prescribe inservice examination

requirements for Class 1 butt welds. Section XI, Appendix VIII, Supplement 11, as modified by table 5, specifies the performance demonstration requirements for ultrasonic examination of weld overlays.

4.0 REASON FOR REQUEST

Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 600/82/182 components exposed to Pressurized Water Reactor (PWR) primary coolant has become a growing concern in the nuclear industry over the past decade. In particular, base metal and weld metal components exposed to elevated temperatures, like the pressurizer, have been shown to pose a heightened propensity to PWSCC. As a result, increased inspection requirements have been applied to these locations via several mechanisms, including 10CFR50.55a, the ASME Code, the recently issued NEI 03-08 Mandatory Guidance, "Primary System Piping Butt Weld Inspection & Evaluation Guideline (MRP-139)," and internal utility Alloy 600 programs.

Many of these requirements call for dramatically improved ultrasonic examination coverage (> 90% of the inner 1/3t of the dissimilar metal weld) and inspection frequencies far in excess of those required by the existing Inservice Inspection (ISI) program. In many cases, these examination coverage requirements are difficult or impossible to meet using current ultrasonic inspection technology due to the short length of the stainless steel safe end between the dissimilar metal and stainless steel welds and the nozzle between the dissimilar metal weld and the nozzle transition.

Due to the combination of inspectability issues and a reduced ability to validate the integrity of these welds prior to the observation of leakage, Comanche Peak has concluded that the application of preemptive structural weld overlays to the susceptible pressurizer nozzle locations is the most appropriate course of action to ensure Reactor Coolant System (RCS) pressure boundary integrity and improve future inspectability.

Structural weld overlays have been used for over 20 years for repair and mitigation of intergranular stress corrosion cracking in boiling water reactors and more recently for repair of PWSCC in pressurized water reactors. In some cases, full structural weld overlays have been used to reestablish structural integrity of DM butt welds containing through wall leaking flaws. Full structural weld overlays arrest existing flaws from propagating by producing favorable residual compressive stresses in the inner portions of the original susceptible welds, provide a PWSCC resistant material, and provide structural reinforcement that meets ASME Code Section XI margins even with existing cracks remaining in the original susceptible welds.

As discussed in this Request, there is no approved comprehensive criterion for Comanche Peak to apply a full structural nickel alloy weld overlay to a DM weld that is constructed of Alloy 82/182 weld material and is believed to be susceptible to or contains PWSCC degradation. Although the ASME Code, Section XI, 1998 Edition through 2000 Addenda Article IWA-4000 is used for the Comanche Peak Repair/Replacement Program, it does not have the needed requirements for this type of weld overlay repair/mitigation. The latest NRC approved ASME Code also does not have the needed requirements for this type of weld overlay. ASME has approved a Code Case (N-740) providing the comprehensive provisions for this type of weld overlay but this Code Case has not yet been approved by the NRC.

Section 3.0 of this Request identifies Code requirements that cannot be met or are not applicable when applying full structural nickel alloy weld overlays as described in this Request. Therefore, in lieu of IWA-4420 (and its referenced original Construction Code for the Pressurizer and attached piping), IWA-4430, IWA-4520(a), IWA-4530, IWA-4600, and the inservice examination requirements of Table IWB-2500-1, alternative requirements are requested for the installation and examination of full structural weld overlays for repairing/mitigating the DM welds and SS welds identified in section 1.0 of this Request. These alternative requirements use methodologies and requirements similar to those in ASME Code Cases N-504-2 and N-638-1. However, as described in section 5.0 of this Request, Cases N-504-2 and N-638-1 cannot be used without modifications.

The Comanche Peak risk-informed ISI Program prescribes inservice examination requirements for Class 1 butt welds that are used in lieu of the requirements of ASME Section XI Table IWB-2500-1. However, with this Request, the weld overlays installed on the welds identified in section 1.0 of this Request will be included in either the augmented or ISI Program Plan for Comanche Peak Unit 2 and will be examined as described in section 5 of this request. The original DM and SS welds will be removed from the Comanche Peak risk-informed ISI Program.

Pursuant to 10CFR50.55a(a)(3)(i), alternatives are requested on the basis that the proposed alternatives will provide an acceptable level of quality and safety.

5.0 PROPOSED ALTERNATIVE AND BASIS FOR USE

A. Proposed Alternative For Application of Weld Overlays Using Modified Code Case N-504-2

A preemptive full structural weld overlay is proposed for each Alloy 82/182 nozzle-to-safe end weld. ASME Code Case N-504-2 allows a flaw to be reduced to an acceptable size through the deposition of weld reinforcement (weld overlay) on the outside surface of the pipe without flaw removal. In this case, the existence of (or lack of) any flaws is not known due to the inability to perform a qualified ultrasonic examination prior to application of the overlays. As such, assumptions are required to be made as to the size and location of flaws which may be present in the original dissimilar metal weld, as discussed below.

Table 1 identifies the materials of construction for the pressurizer nozzle-to-pipe assemblies within the scope of this relief request. Figure 1 shows the generic configuration of the nozzle-to-pipe assemblies but does not reflect the actual external or internal surface profile. In order that both the dissimilar metal nozzle-to-safe end weld and the stainless steel safe end-to-pipe weld are inspectable per the ASME Code post-overlay, the weld overlays will extend from the carbon steel nozzle to the stainless steel pipe.

Figure 1: Generic Pressurizer Nozzle Configuration

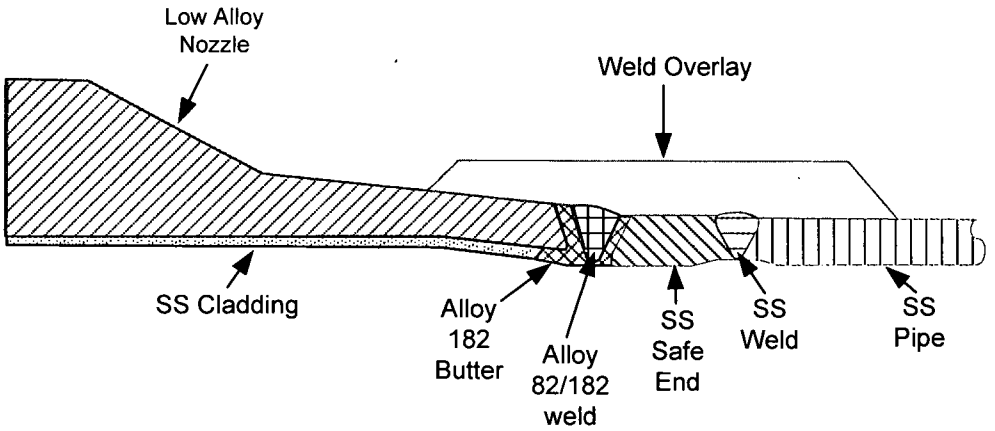

Table 1
Comanche Peak Unit 2 Pressurizer Nozzle Material Identification

Nozzle Type	NPS	Nozzle-Safe End Weld ID Safe End-Pipe Weld ID	Material Identification				
			Nozzle	Nozzle-Safe End Weld	Safe End	Safe End-Pipe Weld	Pipe
Spray	4"	TCX-1-4506-22 TCX-1-4506-21	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER316)	Schedule 160, SA-376, TP 304/TP316
Safety "1"	6"	TCX-1-4501-1 TCX-1-4501-2	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER316/ E316L)	Schedule 160, SA-376-TP304/TP316
Safety "2"	6"	TCX-1-4502-1 TCX-1-4502-2	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER316/ E316L)	Schedule 160, SA-376-TP304/TP316
Safety "3"	6"	TCX-1-4503-1 TCX-1-4503-2	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER316/ E316L)	Schedule 160, SA-376-TP304/TP316
Relief	6"	TCX-1-4504-1 TCX-1-4504-2	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER316/ E316L)	Schedule 160, SA-376-TP304/TP316
Surge	14"	TCX-1-4500-6 TCX-1-4500-5	SA-508, Class 2	DM Shop Weld (Alloy 82/182)	SA-182, Grade F-316L	SS Field Weld (ER308)	Schedule 160, SA-376, Type 316

The weld overlay will be designed consistent with the requirements of ASME Code Case N-504-2, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping," with the modifications noted in Table 2. The weld overlay will extend around the full circumference of the nozzle to- safe end weld location as required by Code Case N-504-2. The specific thickness and length will be calculated according to the guidance provided in Code Case N-504-2 and Nonmandatory App Q. The design of each overlay will assume that a 360° circumferential through-wall flaw is present in the original Alloy 82/182 weld.

The determination of the life of the overlay will be based on the size of any indications in the region of the overlay. Fatigue crack growth evaluations will be performed for the dissimilar metal butt welds to demonstrate that the weld overlay thickness is sized adequately to satisfy the requirements in the flaw evaluation procedures of IWB-3640. The initial flaw size assumed in the fatigue crack growth calculations will be consistent with the post-overlay ultrasonic examination requirements (i.e. a minimum of the outer 25% of the original Alloy 82/182 weld will be inspectable post-overlay). If the crack growth analysis shows that a flaw will not grow to the allowable flaw size for the normal ASME Code, Section XI inspection interval, then the existing Code interval will be used for subsequent in-service inspections. If the crack growth analysis shows that the assumed crack will grow to the allowable flaw size, then the in-service inspection interval will be established based on this time. The allowable flaw size will be that flaw size that meets the analytical requirements of Section XI, IWB-3640.

Preservice inspections, which include the detection and acceptance of welding flaws will be performed in accordance with Code Case N-504-2, Nonmandatory Appendix Q, Subarticle Q-4000, and ASME Section XI, 1998 Edition through 2000 Addenda, Appendix VIII along with Supplement 11.

Code Case N-504-2 is approved for use for austenitic stainless steel material in Regulatory Guide 1.147, Revision 14, provided that it is used with Nonmandatory Appendix Q of the 2005 Addenda of ASME Section XI. An alternate application for nickel-based and carbon materials is proposed due to the configuration of the subject welds, and the lack of an approved code case for these applications. The methodology of Code Case N-504-2 shall be followed with the modifications detailed in Table 2. Details regarding the in-process, pre-service, and inservice examinations that will be applied to the proposed weld overlays are shown in Table 3. These examinations meet all of the requirements of the applicable Codes, as modified by this request.

The above proposed alternative will be implemented during the Comanche Peak Unit 2 2RF10 Refueling Outage (Spring 2008) and provides an acceptable level of quality and safety.

B. Proposed Alternative For Application of Ambient Temperature Machine GTAW Temper Bead Technique Using Modified Code Case N-638-1

Application of the structural weld overlays will require welding to the carbon steel nozzle material. The Code of Construction does not permit welding to the carbon steel nozzle without pre-heat or post-weld heat treatment. In lieu of these requirements, the requirements of ASME Code Case N-638-1, "Similar and Dissimilar Metal Welding Using

Ambient Temperature Machine GTAW Temper Bead Technique," will be met, with the modifications detailed in Table 4.

The ambient temperature temper bead welding technique permits application of the structural weld overlay without the need for elevated preheat or post-weld heat treatment required by ASME Section III. The technique has been qualified and will be performed using the methodology described in ASME Code Case N-638-1. Welding will commence when the base materials exhibit a minimum preheat of 50 degrees Fahrenheit. The interpass temperature during weld installation will not be permitted to exceed a maximum value of 350 degrees Fahrenheit. During the welding, heat input will be precisely controlled to conform to the welding procedure specification.

Code Case N-638-1 contains the requirement that a band around the final weld surface be examined using surface and ultrasonic methods. The band is at least 1.5 times the component thickness or 5 inches, whichever is less. The intent of such examinations is to ensure that no adverse effects have impacted the ferritic steel base material as a result of the temper bead welding process. It is conservatively assumed that the ultrasonic (volumetric) examination requirement for the band is the entire base metal below the band. The most likely adverse effect is the potential for delayed hydrogen cracking which would initiate on the same surface of the ferritic steel base material adjacent to the welding. The ultrasonic inspection is to be conducted in accordance with Appendix I of the ASME Code Section XI.

ASME Code Case N-638-1 requires that final NDE be performed when the completed weld has been at ambient temperature for at least 48 hours. Implementation of the 48 hour hold time will comply with the requirements of N-638-1, with modifications to the hold initiation time as described in Table 4.

With respect to the weld overlay process on pressurizer nozzle dissimilar metal welds, the Code Case N-638-1 defined band and examination volume would encompass the nozzle base metal volume below the outer diameter nozzle tapered surface and a part of the nozzle outer diameter blend region. Being that the inner diameter of the nozzle cannot be reasonably accessed, these outer diameter surfaces must be used as the ultrasonic test probe scanning surfaces. Such surfaces are not conducive for gaining full coverage of the examination volume due to non-coupling of the ultrasonic test probes over the surface; obstructions causing this non-coupling include the edge of the weld overlay, the transition between the OD nozzle taper and the nozzle outer blend area.

Appendix I of the ASME Code Section XI, 1998 Edition through the 2000 Addenda requires that the ultrasonic examination be conducted in accordance with ASME Code Section V, Article 4 and all supplements of Appendix I except Supplement 9 – Scan Angles. The most applicable examination requirements fall under Article 4 T-440 Vessel Examinations. These requirements include straight beam scanning for laminar and planar reflectors and angle beam scanning for planar reflectors. The straight beam scanning will most likely not detect any delayed hydrogen cracking due to misorientation of the cracking with respect to the beam and to the anticipated near surface location of such cracking. Essentially the straight beam is a repeat of the nozzle material examination required by the Construction Code. The angle beam examinations will be largely impacted by the outer diameter surface configuration. To maximize angle beam examination coverage will entail a series of special transducers to be applied even though the most effective angle beam transducers would be those configured to detect

near surface breaking planar reflectors. However the most effective NDT method for detection of near surface breaking planar reflectors is not a volumetric method but a surface examination method.

Relief is requested from the ultrasonic test requirements of Code Case N-638-1 because of the limitations in the applicable ultrasonic test techniques (irregular scan surfaces, effectiveness in detecting the most probable flaw mechanism) combined with the increased radiation exposure of inspection personnel in applying such limited techniques. It is noted that surface examinations will be conducted on this band area to ensure that the most probable flaw mechanism is detected. As such the limited ultrasonic test techniques offer no additional benefit in terms of quality or safety.

Further it is noted that the final weld overlay is to be volumetrically examined using qualified ultrasonic test procedures and personnel in compliance with the PDI Supplement 11 qualification program.

Finally it is noted that the pending ASME Section XI, Code Case N-740, which specifically addresses the weld overlay of dissimilar metal welds including the use of the temper bead process on ferritic base material, mandates only a surface examination of the adjacent ferritic base material to the weld overlay (0.5-inch). Ultrasonic examinations are mandated only over the weld overlay surface and underlying weld and adjacent base material volumes. These inspections are consistent with the requested relief.

As such the nondestructive examination requirements of Code Case N-504-2 and Nonmandatory Appendix Q of the 2005 Addenda of ASME Section XI will be used in lieu of that defined in Code Case N-638-1. Therefore, the NRC condition on use of N-638-1 is not applicable to this Request and will not be applied.

The above proposed alternative will be implemented during the Comanche Peak Unit 2 2RF10 Refueling Outage (Spring 2008) and provides an acceptable level of quality and safety.

Within 14 days of the last ultrasonic examination, a summary of results will be submitted to the NRC.

C. Proposed Alternative to ASME Section XI, Appendix VIII along with Supplement 11

ASME Section XI, 1998 Edition through 2000 Addenda, Appendix VIII, along with Appendix VIII Supplement 11, addresses the requirements for performance demonstration of ultrasonic examination procedures, equipment, and personnel used to detect and size flaws in full structural overlays of wrought austenitic piping welds. Appendix VIII Supplement 11 qualification requirements are modified by the proposed alternatives in the Performance Demonstration Initiative (PDI) program as indicated in Table 5 because the industry cannot meet the requirements of Appendix VIII along with Supplement 11. Therefore, the PDI alternatives to Section XI, Appendix VIII along with Supplement 11 as described in Table 5 will be used for qualification of ultrasonic examinations used to detect and size flaws in the full structural weld overlays of this Request.

6.0 DURATION OF THE PROPOSED ALTERNATIVE

Use of the proposed alternative is requested for the Comanche Peak Unit 2, second In-Service Inspection (ISI) interval. The resulting repairs are requested for the design life of the repairs, as determined by the required evaluation in Paragraph (g) of Code Case N-504-2 and the corresponding requirements in Nonmandatory Appendix Q.

Future ISI examinations of the full structural weld overlays for the butt welds associated with the pressurizer and connected piping will occur per the Comanche Peak Unit 2 ISI Program Plan or the Augmented ISI Program. The ISI examinations will follow the requirements in MRP-139 and ASME Section XI, Nonmandatory Appendix Q.

7.0 PRECEDENT

Similar 50.55a Requests have been approved by the NRC as noted below:

- Three Mile Island Nuclear Station, Unit No. 1
  Docket No. 50-289, TAC No. MC1201, dated July 21, 2004
  Authorized relief from flaw removal, heat treatment, nondestructive examination requirements and weld overlay of nozzle-to-safe end weld.

- Calvert Cliffs Nuclear Power Plant, Unit No. 2
  Docket No. 50-318, TAC Nos. MC6219 and MC6220, dated July 20, 2005
  Authorized use of a weld overlay to repair welds and the Performance Demonstration Initiative (PDI) program for the inspection as alternatives to the ASME Code requirements.

- Donald C. Cook Nuclear Plant, Unit No. 1
  Docket No. 50-315, TAC No. MC6751, dated June 27, 2005
  Authorized use of PDI Program for weld overlay qualifications in lieu of Supplement 11 to Appendix VIII of Section XI of the Code

- Millstone Power Station, Unit No. 3
  Docket No. 50-423, TAC No. MC8609, dated January 20, 2006
  Authorized use of a weld overlay for repair and the Performance Demonstration Initiative (PDI) program for inspection as alternatives to the ASME Code requirements.

- Susquehanna Steam Electric Station Unit 1
  Docket No. 50-387, (TAC Nos. MC2450, MC2451 and MC2594), Accession Number ML051220568, dated June 22, 2005
  Authorized use of a weld overlay for repair and the Performance Demonstration Initiative (PDI) program for inspection as alternatives to the ASME Code requirements.

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
Reply: It is the opinion of the Committee that, in lieu of the requirements of IWA-4120 in Editions and Addenda up to and including the 1989 Edition with the 1990 Addenda, in IWA-4170(b) in the 1989 Edition with the 1991 Addenda up to and including the 1995 Edition, and in IWA-4410 in the 1995 Edition with the 1995 Addenda and later Editions and Addenda, defects in austenitic stainless steel piping may be reduced to a flaw of acceptable size in accordance with IWB-3640 from the 1983 Edition with the Winter 1985 Addenda, or later Editions and Addenda, by deposition of weld reinforcement (weld overlay) on the outside surface of the pipe, provided the following requirements are met.	*Modification:* Code Case N-504-2 and Section XI Nonmandatory Appendix Q in the 2005 Addenda will be used for the application of Alloy 52/52M of the weld overlay of the ferritic (P3) nozzle material, nickel alloy (F43/P43) weld material, and austenitic stainless steel base (P8, safe end and pipe) and weld materials, as modified herein. *Basis:* Code Case N-504-2 is accepted for use in the current NRC Regulatory Guide 1.147 Rev. 14, and has been used extensively in BWR primary system piping. More recently, N-504-2 has been applied to PWR applications, with modifications, for the weld overlay repair of dissimilar metal welds with known flaws. Industry operating experience in the area has shown that PWSCC in Alloy 82/182 will arrest at the interface with stainless steel base metal, ferritic base metal, or Alloy 52/52M/152 weld metal. The 360° full structural weld overlay will control growth in any PWSCC crack and maintain weld integrity. The weld overlay will also induce compressive stress in the weld, thus potentially impeding growth of any reasonably shallow cracks. Furthermore, the overlay will be sized to meet all structural requirements without considering the existing Alloy 82/182 and SS welds .
Paragraph (b): Reinforcement weld metal shall be low carbon (0.035% max.) austenitic stainless steel applied 360 deg. around the circumference of the pipe, and shall be deposited in accordance with a qualified welding procedure specification identified in the Repair Program.	*Modification*: A nickel alloy, specifically Alloy 52/52M, will be used as the reinforcement weld metal in lieu of austenitic stainless steel filler material. *Basis:* The filler material used will be ERNiCrFe-7A (Alloy 52M, UNS N06054) or ERNiCrFe-7 (Alloy 52, UNS N06052). Repairs, if required, may use Alloy 52, Alloy 52M, or ENiCrFe-7 (Alloy 152, UNS W86152). Alloy 52 and Alloy 152 materials are listed in the ASME Code, Section II and Section IX as F-No. 43 and are

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
	acceptable for use under the ASME Code. Alloy 52M is assigned F-No. 43 by ASME per Code Case 2142-2. The requirements of ASME Section III, NB-2400 will continue to be applied to all filler material as required by ASME Section XI. The chromium content of Alloys 52/52M/152 is 28-31.5%. Alloy 52M contains higher Niobium content (0.5- 1 %), which improves the weldability of the material and pins the grain boundaries, thus preventing separation between the grains and hot tearing during weld puddle solidification. These filler materials are selected for their improved resistance to PWSCC. Alloys 52, 52M and 152 all contain about 30% chromium (roughly twice that of Alloy 82/182), imparting excellent corrosion resistance. The existing Alloy 82/182 welds and the Alloy 52/52M overlays are austenitic and have ductile properties and toughness similar to austenitic stainless steel piping welds at PWR operating temperature. Furthermore, these filler materials are suitable for welding over the ferritic nozzle, Alloy 82/182 weld, and the austenitic stainless steel pipe, welds, and safe ends.
Paragraph (c): Prior to deposition of the weld reinforcement, the surface to be repaired shall be examined by the liquid penetrant method. Indications greater than 1/ 16 in. are unacceptable and shall be prepared for weld reinforcement in accordance with (1) or (2) below: (1) Unacceptable indication shall be excavated to the extent necessary to create a cavity that can be repaired using qualified welding procedures.	*Modifications:* In addition to the provisions in N-504-2 paragraphs (c) and (d), near-surface discontinuities identified by pre-weld overlay examinations (UT) may be prepared for weld overlay using provisions of (c) and will be examined using the provisions of (d). *Basis:* Code Case N-504-2 already specifies how to prepare the surface for weld overlay installation and addresses indication

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
(2) One or more layers of weld overlay shall be applied to seal unacceptable indications in the area to be repaired without excavation. The thickness of these layers shall not be included in meeting weld reinforcement design thickness requirements.	identified by surface examinations. This modification just expands these already acceptable provisions to near-surface discontinuities that may be identified in the pre-weld overlay UT examinations.
Paragraph (d): If the preparation of (c)(1) or (c)(2) above is required, the area where the weld reinforcement is to be deposited, including any local repairs or initial weld overlay layers, shall be examined by the liquid penetrant method, and shall contain no indications greater 1/16 in. prior to the application of the structural layers of the weld overlay.	
Paragraph (e): The weld reinforcement shall consist of a minimum of two weld layers having as-deposited delta ferrite content of at least 7.5 FN. The first layer of weld metal with delta ferrite content of least 7.5 FN shall constitute the first layer of the weld reinforcement design thickness. Alternatively, first layers of at least 5 FN may be acceptable based on evaluation.	*Modification:* Delta ferrite (FN) measurements will not be performed when using Alloy 52/52M/152 filler material. The weld overlay deposit shall meet the following requirements: The austenitic nickel alloy weld overlay shall consist of at least two weld layers deposited from a filler material with a Cr content of at least 28%. The first layer of weld metal deposited may not be credited toward the required thickness. Alternatively, a diluted layer may be credited toward the required thickness, provided the portion of the layer over the austenitic base material, austenitic filler material weld and the associated dilution zone from an adjacent ferritic base material contains at least 24% Cr and the Cr content of the deposited weld metal is determined by chemical analysis of the production weld or of a representative coupon taken from a mockup prepared in accordance with the WPS for the production weld. *Basis:* Welds composed of Alloy 52/52M/152 are 100% austenitic and contain no delta ferrite due to the high nickel (approximately 60%) content. The Alloy 52/52M filler material selected for these

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
	repairs is fully austenitic and is, therefore, exempt from delta ferrite content requirements. Alternatively, deposit chromium content provides a suitable alternate basis for first layer deposit acceptance in PWSCC resistant structural weld overlays. N-504-2 does not identify first-layer acceptance criteria for fully austenitic deposits, however, draft ASME Code Case N-740 (and its accompanying technical justification) identify 24% chromium as an acceptable measure of first-layer deposit acceptability in PWR applications. For structural weld overlay repairs, verification of first layer acceptability will be accomplished using draft N-740 methodology. To accomplish this, first layer overlay deposit chemistry will be verified either by field chemistry measurements or by prior mockup demonstration using comparable welding parameters. When first-layer surface chemistry meets or exceeds 24% chromium, this initial layer will be credited toward structural overlay deposit thickness. When first-layer surface chemistry chromium is less than 24% chromium, the first layer will be considered sacrificial and will not be credited toward structural overlay deposit thickness.
Paragraphs (f) and (g) and Q-3000 – Design Considerations	*Modifications:* The provisions of N-504 (f) and (g), Q-3000 in the 2005 Addenda of Section XI, and corrections to Q-3000 to be published in the 2006 Addenda of Section XI will be used. *Basis:* ASME Code action BC 05-1530 approved a revision to Appendix Q, which will be published in the 2006 Addenda of ASME Section XI. The explanation for this revision notes that the action was correcting wording in Nonmandatory Appendix Q, which was first published in the 2005 Addenda. It was approved as part of BC03-1658 as the incorporation of Code Case N-504-2. However, some inadvertent consequences of changed

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
	wording during the incorporation of Case N-504-2 created problems in implementation. Therefore, two corrections were approved in the revision to Appendix Q to immediately fix the problems. The correction to Q-3000(b) was to delete the requirement for the design of the overlay to satisfy the requirements of the Construction Code and Owner's requirements. There was no similar wording in Code Case N-504-2. This wording was inappropriate because meeting the requirements of the Construction Code required the absence of cracks. However, the primary purpose of the Appendix and Code Case N-504-2 was to repair cracks with the external weld overlay. The appropriate requirements for maintaining Section III (i.e., the Construction Code) limits were properly transferred from Case N-504-2 into Q-3000(b)(1) in the initial issue of Appendix Q and the deletion in Q-3000(b) resolved the problem. Regarding the correction in Q-3000(b)(3), "overlay design thickness" is more appropriate than "pressure design", which is incorrect and was not used in Code Case N-504-2. Overlay design thickness is based on other loads in addition to pressure.
Paragraph *(h):* The completed repair shall be pressure tested in accordance with IWA-5000. If the flaw penetrated the original pressure boundary prior to welding, or if any evidence of the flaw penetrating the pressure boundary is observed during the welding operation, a system hydrostatic test shall be performed in accordance with IWA-5000. If the system pressure boundary has not been penetrated, a system leakage, inservice, or functional test shall be performed in accordance with IWA-5000.	*Modification:* In lieu of a hydrostatic test, a system leakage test will be performed in accordance with Section XI, IWA-5000 in the 2000 Addenda. *Basis:* A system hydrostatic test at 1.02 times Class 1 reactor coolant system operating pressure at normal operating temperature (as required by IWA-5000 and IWB-5000) is of no value. It provides no more assurance about the structural condition of the weld overlay than the system leakage test performed at Class 1 reactor coolant system operating pressure.

Table 2: Modifications to Code Case N-504-2 and Corresponding Nonmandatory Appendix Q Requirements

Code Case N-504-2 and Nonmandatory Appendix Q	Modification and Basis
	ASME Section XI concluded this years ago and eliminated Class 1 system hydrostatic tests for inservice inspections starting in the 1993 Addenda. ASME Section XI also issued Code Case N-416-1, which was accepted by the NRC, which substituted system leakage tests for system hydrostatic tests following repairs and replacements. ASME Section XI incorporated Code Case N-416-1 into IWA-4540 in the 1999 Addenda allowing a system leakage test to be used in lieu of a system hydrostatic test. A provision of the Code Case and the incorporation of the Case required examinations to be performed as required by ASME Section III because these examinations tell much more about the condition of the repair/replacement activity than any Section XI pressure test. However, the Section III examinations are not well suited to the weld overlay configuration. For the application of weld overlays, extensive surface and volumetric examinations of the weld overlay are required by Code Case N-504-2 and Nonmandatory Appendix Q, providing equivalent assurance of the quality of the overlay as the Section III examinations.

Table 3: Weld Overlay Examination Requirements

IN-PROCESS EXAMINATIONS				
Examination Description	**Method**	**Technique**	**Reference**	**Acceptance Standards**
Safe end, welds, nozzle, and pipe pre-overlay surface preparation	Surface	Liquid Penetrant	N-504-2 and Q-2000	N-504-2, Paragraph (c), Q- 2000(b)
Corrective layers of weld metal , if required, not associated with the structural weld overlay	Surface	Liquid Penetrant	N-504-2 and Q-2000	N-504-2, Paragraph (d), Q- 2000(c)
Thickness measurement for verifying final deposited weld reinforcement	Volumetric	UT-0°L	N-504-2 and Q-3000	Per weld overlay design requirements and Q-3000
PRE-SERVICE EXAMINATION REQUIREMENTS				
Examination Description	**Method**	**Technique**	**Reference**	**Acceptance Standards**
Completed weld overlay for adequate fusion with the base metal and to detect welding flaws. Examination for bonding and welding flaws in the portion of the weld overlay installed per Case N-638-1 will occur at least 48 hrs. after the third temperbead weld layer has been completed.	Volumetric	UT-0°L; UT angle beam per PDI-qualified procedure	N-504-2, N-638-1, Q-4100, and Appendix VIII	Per weld overlay design requirements, Q-3000, and Q-4100(c)
Examination of the completed weld overlay and examination of a band at least 0.50 inches outward from the toe of the weld overlay around the entire circumference of the nozzle and pipe. For the portion of the weld overlay installed per Code Case N-638-1 and the band area on the nozzle side, this examination will occur at least 48 hrs. after the third temperbead weld layer has been completed.	Surface	Liquid Penetrant	N-504-2, N-638-1, and Q-4100	Q-4100(b)

Table 3: Weld Overlay Examination Requirements

Completed weld overlay and the outer 25 percent of the original DM weld thickness at least 0.5- inch beyond the toes of the original DM weld and butter and at least 0.5 inches beyond any as-found flaw. For N-638-1 welding, this examination will occur at least 48 hrs. after the third temperbead weld layer has been completed.	Volumetric	UT angle beam per PDI-qualified procedure	N-504-2, N-638-1, Q-4200, and Appendix VIII	N-504-2, Paragraph (i) and Q-4200
Completed weld overlay and the outer 25 percent of the original SS pipe weld thickness at least 0.5- inch beyond the toes of the original SS weld and at least 0.5 inches beyond any as-found flaw.	Volumetric	UT angle beam per PDI-qualified procedure	N-504-2, Q-4200, and Appendix VIII	N-504-2, Paragraph (i) and Q-4200
INSERVICE EXAMINATION REQUIREMENTS				
Examination Description	**Method**	**Technique**	**Reference**	**Acceptance Standards**
Full Structural Repair WOL: Weld overlay and outer 25 percent of the original DM weld thickness at least 0.5-inches beyond the toes of the original DM weld and butter, and at least 0.5 inches beyond any as-found flaw, will be examined within the next two refueling outages. Re-examination will be on a sampling basis in accordance with Q-4300(b) through (f) and Q-4310. These examinations will be added to the ISI or Augmented ISI Program Plan in accordance with IWB-2412(b)(1).	Volumetric	UT angle beam per PDI procedure	ASME Section XI Appendix VIII and Q-4300	Q-4300

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
Paragraph 1.0(a): The maximum area of an individual weld based on the finished surface shall be 100 sq. in., and the depth of the weld shall not be greater than one-half of the ferritic base metal thickness.	*Modification:* The maximum area of a weld overlay over the ferritic nozzle material will be 300 sq. in. The one-half base metal thickness limitation applies only to excavations and repairs, and is not applicable to weld overlays covered by this 50.55a Request. *Basis:* Only one of the six weld overlays within the scope of this request (the surge nozzle) will exceed the 100 square inch overlay area limitation on the ferritic base material. Review of the surge nozzle weld overlay design drawings indicates that a best estimate weld overlay surface area of 155 square inches will be applied to the nozzle material. All other nozzle weld overlay surface areas will be less than 100 square inches. The Comanche Peak surge nozzle application is similar to the Susquehanna application in that the full structural weld overlay induces compressive stress in the original 82/182 weld, which supports mitigation of the degradation mechanism of concern (primary water stress corrosion cracking), and the geometry, consisting of a carbon steel nozzle welded to a stainless steel safe end with Alloy 82/182, is of similar size and configuration. The NRC acceptance of the Susquehanna relief request was not based on specific design and stresses but on the industry work demonstrating the acceptability of larger areas of ambient temperature temper bead welding. Because the basis was not specific to Susquehanna, Comanche Peak referred to that approval. ASME has approved Code Case N-638-3, which increased the 100 square inch limitation to 500 square inches. The technical basis accompanying the Code Case revision provides an expanded basis for the change in area limitation, citing no direct correlation to the amount of surface area when comparing

	residual stresses for overlay repairs done using temperbead welding. As surface areas of up to 500 square inches have been shown through testing and analysis to continue to result in compressive residual stresses in the weld region, the proposed surge nozzle overlay will have no adverse impact on the pressure boundary function of the nozzle. In addition, it is noted that since the weld overlays are fabricated from nickel based Alloy 52/52M materials with high resistance to PWSCC and inherent toughness, no cracking in the overlays is expected to occur due to the shrinkage associated with the weld overlay. With respect to the low alloy steel material in the nozzle, many temper bead weld overlays have been applied in the nuclear industry to these nozzle-to-safe end locations. In no instance has there been any reported cracking due to the weld overlay application. The stiffness and high toughness inherent in the low alloy steel nozzle is expected to protect against any cracking and limit any distortion that might occur in the nozzle. Comanche Peak will be measuring and evaluating axial shrinkage. Also, any cracking that might occur should be detected by the final NDE of the weld overlay. Laboratory testing and field experience have been documented qualifying the temper bead weld overlay repair for nozzle-to-safe-end welds and these efforts and experience have demonstrated that the remedy provides a quality, sound repair that maintains structural integrity, thus demonstrating an acceptable level of quality and safety. Weld shrinkage caused by application of the overlays will be measured and evaluated for any system impacts, as required by Code Case N-504- 2, Paragraph (g)(3). The weld shrinkage effects on the attached piping and support systems will be assessed prior to the weld overlay based on estimated weld shrinkage. The preliminary evaluation of weld

	shrinkage for the surge and spray line are complete and the preliminary evaluation for the safety/relief lines will be completed by February 2008. Confirmatory analyses based on actual weld shrinkage measurements after the weld overlay will be performed, and a formal letter will be provided. The final evaluation will be completed within two weeks of the receipt of final measurements. As per current schedule the evaluation will be completed by April 2008. The plant is scheduled to re-start April 2008.

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
Paragraph 4.0(b): The final weld surface and the band around the area defined in para. 1.0(d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I.[3] *Paragraph 1.0(d) (by reference in 4.0(b)):* Prior to welding the area to be welded and a band around the area of at least 1-1/2 times the component thickness or 5 in., whichever is less shall be at least 50°F. [3] Refer to the 1989 Edition with the 1989 Addenda and later Editions and Addenda.	*Modification:* In lieu of the requirements of paragraph 4.0(b), examination of the final weld overlay and a one half-inch band around the final weld overlay will be in accordance with the requirements of Code Case N-504-2 and Nonmandatory Appendix Q, as modified in this relief request. The results of these examinations will be evaluated in accordance with Appendix Q, Para. Q-4100(b) and Q-4100(c) *Basis:* Code Case 638-1 applies to any type of welding where a temper bead technique is to be employed and is not specifically written for a weld overlay repair. However, for a weld overlay, any base material cracking would take place in the HAZ directly below the weld overlay or in the underlying Alloy 82/182 weld deposit and not in the required band of material out beyond the overlay. Therefore, if this cracking were to occur it would be identified by the ultrasonic examination of the weld overlay in accordance with N-504-2 and Appendix Q. The band is not in close proximity to the DM weld and if flaws in the DM weld were to propagate, they would arrest at the interface with the ferritic base material or the Alloy 52/52M/152 weld metal and be contained in the volume of material that is subject to preservice examinations. Furthermore, in Case N-638-2 ASME has removed the requirement to examine the 1.5 times the component thickness band as no longer necessary to assure acceptability. In addition, the NRC has previously granted relief on this specific issue at Millstone Unit 3 in NRC letter dated Jan. 20, 2006. With this modification, the NRC Reg. Guide 1.147, Revision 14, condition on use of N-638-1 is not applicable and will not be applied.

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
	Reg Guide 1.147 Rev. 14 Table 2. "Conditionally Acceptable Section XI Code Cases", N638-1 identifies acceptance criteria of NB-5330 of Section III edition and addenda approved in 10 CFR 50.55a apply to all flaws identified within the repaired volume. Code Case 638-1 applies to any type of welding where a temper bead technique is to be used and is not specifically written for a weld overlay repair. Code Case N-504-2 and Nonmandatory Appendix Q are applicable for weld overlay repairs. Thus the final full structural weld overlay and heat-affected zone beneath the weld overlay will be examined in accordance with the requirements of Code Case N-504-2 and Nonmandatory Appendix Q. The acceptance criteria in Nonmandatory Appendix Q section Q-3000 will be used. Comanche Peak will provide a summary of UT examination results of the weld overlays within 14 days of completion of the work.
Paragraph 4.0(b): The final weld surface and the band around the area defined in para. 1.0(d) shall be examined using a surface and ultrasonic methods when the completed weld has been at ambient temperature for at least 48 hours. The ultrasonic examination shall be in accordance with Appendix I.[3]	Modification: In lieu of the requirements of paragraph 4.0(b), the examination of the final weld will be in accordance with the requirements of Code Case N-504-2 and Appendix Q, as modified in this relief request. The 48 hour hold time may start following completion of the third temperbead weld layer. Final weld NDE shall be performed no sooner than 48 hours after completion of that portion of the third temperbead layer that covers or adjoins the ferritic base material. *Basis:* The 48 hour delay between return of the repair weld to ambient temperature and final NDE serves to enable detection of delayed hydrogen cracking in the ferritic nozzle heat affected zone (HAZ). Delayed hydrogen cracking may occur in the ferritic HAZ as a result of the introduction of deleterious monatomic

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
	hydrogen into the hardened HAZ microstructure. Cracking susceptibility is highest in regions where effective HAZ tempering has not been achieved. Since only the ferritic nozzle HAZ is susceptible to delayed hydrogen cracking, only the first Alloy 52M layer on this nozzle has the potential to create a condition susceptible to delayed hydrogen cracking. Hydrogen contamination at deleterious levels is unlikely when the ambient temperature temperbead machine GTAW process is used. This welding process employs specific methodologies, welding controls, cleanliness controls, and nondestructive examinations, each serving to minimize exposure to outside hydrogen contamination sources. Compared to flux-type welding processes, machine GTAW with argon shielding is an inherently low-hydrogen process. Machine GTAW provides optimum temperbead welding controls to ensure effective HAZ tempering and correspondingly high HAZ fracture toughness. The low hydrogen characteristics and HAZ tempering effectiveness of machine GTAWW are well documented in EPRI Report GC-111050, "Ambient Temperature Preheat for Machine GTAW Temperbead Applications," (Ref. Electric Power Research Institute GC-111050, "Ambient Temperature Preheat for Machine GTAW Temperbead Applications", November 1998). Code Case N-504-2 and Appendix Q require liquid penetrant examination (PT) prior to weld installation. PT examination requires cleaning of the weld surface before and after the examination. This cleaning, which is performed in addition to that typically performed for welding preparations, ensures the weld surfaces are essentially free of surface contaminants. This freedom from external contaminants minimizes the potential for introduction of deleterious hydrogen levels into the first layer of the weld deposit.

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
	The austenitic Alloy 52/52M/52MS filler material employed for these welds has an inherently high affinity for monatomic hydrogen, as well as a low monatomic hydrogen diffusion coefficient. These inherent material characteristics serve to minimize diffusion of deleterious hydrogen into the ferritic base material, thereby ensuring negligible hydrogen levels in the ferritic HAZ. Further, only welding that contacts the ferritic low alloy base material has the potential to introduce deleterious monatomic hydrogen into a hardened HAZ region. Each successive temperbead layer has an increasing distance from the HAZ region and has, therefore, a correspondingly decreasing propensity to introduce monatomic hydrogen into the susceptible HAZ region. The second and third weld layers effectively temper the martensite formed in the ferritic base material by the first weld layer. Tempering achieved by the second and third layers decreases HAZ hardness and increases fracture toughness in this susceptible region. This effective tempering mitigates delayed hydrogen cracking susceptibility. Interpass temperature controls imposed by Code Case N-638-1 further mitigate delayed hydrogen cracking susceptibility. N-638-1 imposes a 350ºF maximum interpass temperature for all weld passes. This low interpass temperature serves to ensure high base metal cooling rates and corresponding high fracture toughness values. These interpass temperatures maintain the ferritic base metal HAZ at correspondingly low values, effectively contributing to time at or near ambient temperature. When welding increases temperatures to values above ambient, these times at elevated temperatures serve the beneficial purpose of enhancing hydrogen diffusion, facilitating diffusion of hydrogen away from the ferritic base metal HAZ. It is, therefore, both reasonable and conservative to include the temperbead welding

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
	time following third layer completion in the 48 hour NDE hold time. In summary, the inherent low hydrogen nature of the ambient temperature machine GTAW process, the process controls and restrictions inherent in ambient temperature welding methodology, the relatively low alloy ferritic steel HAZ susceptibility to delayed hydrogen cracking when using nickel alloy filler metals, and performance of final NDE 48 hours after completion of the third weld layer over the ferritic base material provide substantial measures effectively mitigating the potential for delayed hydrogen cracking in the ferritic base material HAZ. Additionally, the Boiler and Pressure Vessel Main Committee, in August 2006, approved revision 3 to Code Case N-638 (Published as N-638-3) which permits the 48 hour NDE hold to begin upon completion of the third tempering weld layer (Reference ASME Code Committee tracking number BC06-134). Relief similar to that requested herein was previously approved for use at the Callaway Nuclear Station for pressurizer nozzle overlay installation in Spring, 2007.
Paragraph 4.0(c): Use of weld-attached thermocouples and recording instruments is not clearly stated but may be implied. When weld-attached thermocouples are used, the area from which the thermocouples have been removed shall be ground and examined using a surface examination.	*Modification:* In lieu of weld-attached thermocouples and recording instruments, process temperatures will be monitored with non-attached devices, such as contact pyrometers, which will enable manual recording of process temperatures. Process temperature monitoring is performed to ensure compliance with the applicable Welding Procedure Specification preheat/interpass temperature requirements during overlay welding. Interpass temperature, temperature of a previously deposited weld pass prior to depositing a subsequent weld pass, must be measured at the start location of the successive weld pass prior to commencement of welding. Attached

Table 4: Modifications to Code Case N-638-1

Code Case N-638-1 Section	Modification and Basis
	thermocouples are not practical for this application because they must be fixed at specific location(s). However, a contact pyrometer permits interpass temperature measurement at any location determined to be the starting point for the respective successive weld pass. The accuracy of temperature measurements from a contact pyrometer and attached thermocouple are comparable. Instruments used will be calibrated in accordance with approved calibration and control program requirements.

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

SUPPLEMENT 11 - QUALIFICATION REQUIREMENTS FOR FULL STRUCTURAL OVERLAID WROUGHT AUSTENITIC PIPING WELDS	PDI PROGRAM: The Proposed Alternative to Supplement 11 Requirements
1 .0 SPECIMEN REQUIREMENTS	
1.1 General. The specimen set shall conform to the following requirements.	
(b) The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 in. or larger, the specimen set must include at least one specimen 24 in. or larger but need not include the maximum diameter. The specimen set must include at least one specimen with overlay thickness within -0.1 in. to +0.25 in. of the maximum nominal overlay thickness for which the procedure is applicable.	*Alternative*: *(b))* The specimen set shall consist of at least three specimens having different nominal pipe diameters and overlay thicknesses. They shall include the minimum and maximum nominal pipe diameters for which the examination procedure is applicable. Pipe diameters within a range of 0.9 to 1.5 times a nominal diameter shall be considered equivalent. If the procedure is applicable to pipe diameters of 24 in. or larger, the specimen set must include at least one specimen 24 in. or larger but need not include the maximum diameter. The specimen set must include at least one specimen with overlay thickness within -0.1 in. to +0.25 in. of the maximum nominal overlay thickness for which the procedure is applicable.. *Basis*: To avoid confusion, the overlay thickness tolerance contained in the last sentence was reworded and the phrase "and the remainder shall be alternative flaws" was added to the next to last sentence in paragraph 1.1(d)(1).
(d) Flaw Conditions	
(1) *Base metal flaws.* All flaws must be cracks in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. Flaws may extend 100% through the base metal and into the overlay material; in this case, intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the cracking. Specimens containing IGSCC shall be used when available.	*Alternative:* (1) *Base metal flaws.* All flaws must be cracks in or near the butt weld heat-affected zone, open to the inside surface, and extending at least 75% through the base metal wall. Flaws may extend 100% through the base metal and into the overlay material; in this case, intentional overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the cracking. Specimens containing IGSCC shall be used when available. At least 70% of the flaws in the detection and sizing

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	tests shall be cracks and the remainder shall be alternative flaws. Alternative flaw mechanisms, if used, shall provide crack-like reflective characteristics and shall be limited by the following: (a) The use of alternative flaws shall be limited to when the implantation of cracks produces spurious reflectors that are uncharacteristic of actual flaws. (b) Flaws shall be semi elliptical with a tip width of less than or equal to 0.002 inches. *Basis:* This paragraph requires that all base metal flaws be cracks. 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. To resolve this issue, the PDI program revised this paragraph to allow use of alternative flaw mechanisms under controlled conditions. For example, alternative flaws shall be limited to when implantation of cracks precludes obtaining an effective ultrasonic response, flaws shall be semi elliptical with a tip width of less than or equal to 0.002 inches, and at least 70% of the flaws in the detection and sizing test shall be cracks and the remainder shall be alternative flaws. To avoid confusion, the overlay thickness tolerance contained in paragraph 1.1(b) last sentence, was reworded and the phrase "and the remainder shall be alternative flaws" was added to the next to last sentence. Paragraph 1.1(d)(1) includes the statement that intentional

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	overlay fabrication flaws shall not interfere with ultrasonic detection or characterization of the base metal flaws.
(e) Detection Specimens	
(1) At least 20% but less than 40% of the flaws shall be oriented within ± *20°* of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. The rules of IWA-3300 shall be used to determine whether closely spaced flaws should be treated as single or multiple flaws.	*Alternative:* (1) At least 20% but less than 40% of the base metal flaws shall be oriented within ± *20°* of the pipe axial direction. The remainder shall be oriented circumferentially. Flaws shall not be open to any surface to which the candidate has physical or visual access. *Basis:* The requirement for axially oriented overlay fabrication flaws was excluded from the PDI Program as an improbable scenario. Weld overlays are typically applied using automated GTAW techniques with the filler metal applied in a circumferential direction. Because resultant fabrication induced discontinuities would also be expected to have major dimensions oriented in the circumferential direction axial overlay fabrication flaws are unrealistic. The requirement for using IWA-3300 for proximity flaw evaluation was excluded, instead indications will be sized based on their individual merits.
(2) Specimens shall be divided into base and overlay grading units. Each specimen shall contain one or both types of grading units.	*Alternative:* (2) Specimens shall be divided into base metal and overlay fabrication grading units. Each specimen shall contain one or both types of grading units. Flaws shall not interfere with ultrasonic detection or characterization of other flaws.
(a)(1) A base grading unit shall include at least 3 in. of the length of the overlaid weld. The base grading unit includes the outer 25% of the overlaid weld and base metal on both sides. The base grading unit shall not include the inner 75% of the overlaid weld and base metal overlay material, or base metal-to-overlay interface.	*Alternative: (a)(1)* A base metal grading unit includes the overlay material and the outer 25% of the original overlaid weld. The base metal grading unit shall extend circumferentially for at least 1 in. and shall start at the weld centerline and be wide enough in the axial direction to encompass one half of the original weld crown and a minimum of 0.50" of the adjacent base material. *Basis:* The phrase "and base metal on both sides," was

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	inadvertently included in the description of a base metal grading unit. The PDI program intentionally excludes this requirement because some of the qualification samples include flaws on both sides of the weld. To avoid confusion several instances of the term "cracks" or "cracking" were changed to the term "flaws" because of the use of alternative Flaw mechanisms. Modified to require that a base metal grading unit include at least 1 in. of the length of the overlaid weld, rather than 3 inches.
(a)(2) When base metal cracking penetrates into the overlay material, the base grading unit shall include the overlay metal within 1 in. of the crack location. This portion of the overlay material shall not be used as part of any overlay grading unit.	*Alternative:* (a)(2) When base metal flaws penetrate into the overlay material, the base metal grading unit shall not be used as part of any overlay fabrication grading unit.
(a)(3) When a base grading unit is designed to be unflawed, at least 1 in. of unflawed overlaid weld and base metal shall exist on either side of the base grading unit. The segment of weld length used in one base grading unit shall not be used in another base grading unit. Base grading units need not be uniformly spaced around the specimen.	*Alternative:* (a)(3) Sufficient unflawed overlaid weld and base metal shall exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws. Modified to require sufficient unflawed overlaid weld and base metal to exist on all sides of the grading unit to preclude interfering reflections from adjacent flaws, rather than the 1 inch requirement.
(b)(1) An overlay grading unit shall include the overlay material and the base metal-to-overlay interface of at least 6 in^2. The overlay grading unit shall be rectangular, with minimum dimensions of 2 in.	*Alternative: (b)(1)* An overlay fabrication grading unit shall include the overlay material and the base metal-to-overlay interface for a length of at least 1 in. Modified to define an overlay fabrication grading unit as including the overlay material and the base metal-to-overlay interface for a length of at least 1 in, rather than the 6 in^2 requirement.
(b)(2) An overlay grading unit designed to be unflawed shall be surrounded by unflawed overlay material and unflawed base metal-to overlay interface for at least 1 in. around its entire perimeter. The specific area used in one overlay grading unit shall not be used in another overlay grading unit. Overlay grading units need not be spaced uniformly about the specimen.	*Alternative:* (b)(2) Overlay fabrication grading units designed to be unflawed shall be separated by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 in. at both ends. Sufficient unflawed overlaid weld and base metal shall exist on both sides of the overlay fabrication grading unit to preclude interfering reflections from adjacent flaws. The specific

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	area used in one overlay fabrication grading unit shall not be used in another overlay fabrication grading unit. Overlay fabrication grading units need not be spaced uniformly about the specimen. *Basis:* Paragraph 1.1(e)(2)(b)(2) states that overlay fabrication grading units designed to be unflawed shall be separated by unflawed overlay material and unflawed base metal-to-overlay interface for at least 1 in. at both ends, rather than around its entire perimeter.
(b)(3) Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base grading units, ten unflawed base grading units, five flawed overlay grading units, and ten unflawed overlay grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units.	*Alternative:* Detection sets shall be selected from Table VIII-S2-1. The minimum detection sample set is five flawed base metal grading units, ten unflawed base metal grading units, five flawed overlay fabrication grading units, and ten unflawed overlay fabrication grading units. For each type of grading unit, the set shall contain at least twice as many unflawed as flawed grading units. For initial procedure qualification, detection sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.
(f) *Sizing Specimen*	
(1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be cracks open to the inside surface.	*Alternative:* (1) The minimum number of flaws shall be ten. At least 30% of the flaws shall be overlay fabrication flaws. At least 40% of the flaws shall be open to the inside surface. Sizing sets shall contain a distribution of flaw dimensions to assess sizing capabilities. For initial procedure qualification, sizing sets shall include the equivalent of three personnel qualification sets. To qualify new values of essential variables, at least one personnel qualification set is required.
(3) Base metal cracking used for length sizing demonstrations shall be oriented circumferentially.	*Alternative:* (3) Base metal flaws used for length sizing demonstrations shall be oriented circumferentially.
(4) Depth sizing specimen sets shall include at least two distinct locations where cracking in the base metal extends into the	*Alternative:* (4) Depth sizing specimen sets shall include at least two distinct locations where a base metal flaw extends into the

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

overlay material by at least 0.1 in. in the through-wall direction.	overlay material by at least 0.1 in. in the through-wall direction.
2 .0 CONDUCT OF PERFORMANCE DEMONSTRATION	
The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of unmasked specimens after the performance demonstration is prohibited.	*Alternative:* The specimen inside surface and identification shall be concealed from the candidate. All examinations shall be completed prior to grading the results and presenting the results to the candidate. Divulgence of particular specimen results or candidate viewing of unmasked specimens after the performance demonstration is prohibited. The overlay fabrication flaw test and the base metal flaw test may be performed separately
2.1 Detection Test	
Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base or overlay) that are present for each specimen.	*Alternative:* Flawed and unflawed grading units shall be randomly mixed. Although the boundaries of specific grading units shall not be revealed to the candidate, the candidate shall be made aware of the type or types of grading units (base or overlay) that are present for each specimen.
2.2 Length Sizing Test	
(d) For flaws in base grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base wall thickness.	*Alternative: (d)* For flaws in base grading units, the candidate shall estimate the length of that part of the flaw that is in the outer 25% of the base wall thickness.
2.3 Depth Sizing Test	
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. 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.	*Alternative:* (a) The depth sizing test may be conducted separately or in conjunction with the detection test. (b) When the depth sizing test is conducted in conjunction with the detection test and the detected flaws do not satisfy the requirements of 1.1(f), additional specimens shall be provided to the candidate. The regions 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. (c) For a separate depth sizing test, 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

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	the flaw in each region.
3.0 ACCEPTANCE CRITERIA	
3.1 Detection Acceptance Criteria	
Examination procedures, equipment, and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. The criteria shall be satisfied separately by the demonstration results for base grading units and for overlay grading units.	*Alternative:* Examination procedures are qualified for detection when: a. All flaws within the scope of the procedure are detected and the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for false calls. b. At least one successful personnel demonstration has been performed meeting the acceptance criteria defined in (c). c. Examination equipment and personnel are qualified for detection when the results of the performance demonstration satisfy the acceptance criteria of Table VIII-S2-1 for both detection and false calls. d. The criteria in (b) and (c) shall be satisfied separately by the demonstration results for base metal grading units and for overlay fabrication grading units. *Basis:* The PDI program allows procedure qualification to be performed separately from personnel and equipment qualification. Historical data indicate that, if ultrasonic detection or sizing procedures are thoroughly tested, personnel and equipment using those procedures have a higher probability of successfully passing a qualification test. In an effort to increase this passing rate, PDI has elected to perform procedure qualifications separately in order to assess and modify essential variables that may affect overall system capabilities. For a procedure to be qualified, the PDI program requires three times as many flaws to be detected (or sized) as shown in Supplement 11 for the entire ultrasonic system. The personnel and

Table 5: PDI Program Alternative to Appendix VIII, Supplement 11

	equipment are still required to meet Supplement 11.
3.2 Sizing Acceptance Criteria	
(a) The RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The length of base metal cracking is measured at the 75% through-base-metal position.	*Alternative: (a)* The RMS error of the flaw length measurements, as compared to the true flaw lengths, is less than or equal to 0.75 inch. The length of base metal cracking is measured at the 75% through-base-metal position. .
(b) All extensions of base metal cracking into the overlay material by at least 0.1 in. are reported as being intrusions into the overlay material.	*Alternative:* This requirement is omitted. *Basis:* The requirement for reporting all extensions of cracking into the overlay is omitted from the PDI Program because it is redundant to the RMS calculations performed in paragraph 3.2(c) and its presence adds confusion and ambiguity to depth sizing as required by paragraph 3.2(c). This also makes the weld overlay program consistent with the Supplement 2 depth sizing criteria.