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Acting Director
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CNRO-2005-00014

March 28, 2005

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

SUBJECT: Request for Alternatives W3-R&R-003
Response to NRC Request for Additional Information

Waterford Steam Electric Station, Unit 3
Docket No. 50-382
License No. NPF-38

REFERENCES:

1. Entergy Operations, Inc. letter CNRO-2005-00001 to the NRC dated January 31, 2005
2. Welding Services, Inc. Bases Document, *Cooling Transients for Mid-Wall Weld Repairs*
3. Entergy Operations, Inc. letter CNRO-2005-00017 to the NRC dated March 18, 2005,

Dear Sir or Madam:

Entergy Operations, Inc. (Entergy) recently submitted to the NRC via reference 1, Request for Alternative W3-R&R-003 for use at Waterford Steam Electric Station, Unit 3. W3-R&R-003 proposed alternatives to the temper bead welding requirements of ASME Section XI, IWA-4500 and IWA-4530, which are needed to support the pro-active replacement of pressurizer heater sleeves and instrument nozzles with ones made from a material less susceptible to primary water stress corrosion cracking (PWSCC).

On March 10, 2005, the NRC staff provided to Entergy a Request for Additional Information (RAI) to support the review and approval of W3-R&R-003. Entergy's response to the staff's request is provided in Enclosure 1. Entergy has incorporated these responses into W3-R&R-003, which is provided in Enclosure 2. The enclosed version of W3-R&R-003 replaces in its entirety the version previously submitted to the staff via reference 1.

Reference 2 was provided to the NRC in support of the staff's review of Request for Alternative ANO2-R&R-003 and was submitted via Reference #3.

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Should you have any questions regarding this submittal, please contact Guy Davant at (601) 368-5756.

Sincerely,

FGB/ghd-wbb
Enclosures:

1. Responses to the NRC's Request for Additional Information Supporting Request for Alternative W3-R&R-003
2. Request for Alternative W3-R&R-003

cc: Mr. W. A. Eaton (ECH)
Mr. J. E. Venable (W3)

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ENCLOSURE 1

CNRO-2005-00014

RESPONSES TO NRC's REQUEST FOR ADDITIONAL INFORMATION SUPPORTING REQUEST FOR ALTERNATIVE W3-R&R-003

RESPONSES TO NRC's REQUEST FOR ADDITIONAL INFORMATION SUPPORTING REQUEST FOR ALTERNATIVE W3-R&R-003

The staff of the NRC Materials and Chemical Engineering Branch has reviewed the Entergy Operations Inc. (Entergy) submittal of January 31, 2005, and has determined that additional information is necessary to complete the review of the request for alternative. Based on the staff's review, please provide a response which addresses the following questions:

1. On page 3 of the Request under, "OD Weld Pad Repair of Previously Repaired Upper Head Instrument Nozzles," Entergy states that the existing nozzles and associated attachment welds will be removed by grinding. How will the licensee ensure that all of the 182 filler metal will be moved to minimize the potential for future primary stress corrosion cracking (PWSCC)?

   Entergy's Response: *The design dimensions of the outside diameter weld pads, J-welds, and instruments nozzles are clearly documented in WF3 design drawings. Entergy has also located the original work package documentation for these welds. However, while the work package documentation seems to suggest that the J-weld preparations were made by grinding as opposed to machining, this cannot be confirmed. Therefore, to account for a J-weld that is potentially larger than the minimum required by design, Entergy plans to perform the following:*

   - ***Mock-up Testing:*** *Prior to performing this repair, a full scale mock-up will be prepared based on design drawings to establish the capability of repair personnel to remove the existing 082 weld metal using hand grinding techniques. Depth gauges will be fabricated and used to assist in the excavation activities during the mock-up.*

   - ***Repair Excavation:*** *The excavation activity to remove the 082 weld metal will be performed in several steps. First, the J-weld will be excavated to the original design dimensions in both depth and radial directions. Depth gauges will be used to assist in the excavation activities. If the nozzle is still attached by weld metal at the design depth, then this would indicate that the original weld preparation is deeper than the minimum depth required by design. Grinding in the depth direction of the weld root area will continue until the nozzle becomes free. Once the nozzle becomes free, the bottom of the J-weld preparation (in the weld root area) has been reached. To provide assurance that all 082 weld metal (and 052/082 weld dilution zone) has been removed, an additional 1/16" of weld metal will be ground from the excavation. At this point, Entergy believes that all 082 weld metal will be removed from the weld root area. Based on this final excavation depth in the weld root area, Entergy will perform additional grinding outside the weld root area in the radial direction with the intent of removing all 082 weld metal along the face of the J-weld preparation. Upon completion of all excavation activities, a PT of the repair cavity will be performed.*

   In conclusion, Entergy is confident that it can remove all 082 weld metal from the weld root area along the bottom of the original J-weld preparation. However, Entergy cannot be absolutely certain that all 082 weld metal will be removed from the weld area along the face of the J-weld preparation which is outside of the weld root area since Entergy has been unable to locate any conclusive "as-built" dimensions. Although this is the case, this *will not cause future PWSCC cracking for the following reasons: (1) All 082 weld metal will be removed from the weld root area and replaced with 052/052 Modified weld metal which is resistant to PWSCC. The J-weld root area is the only portion of the J-weld that will be exposed to primary water. (2) Although there is a potential that some 082 weld metal may be left from the original weld along the J-weld face, this weld metal is located away from the weld root and will be isolated from primary water by resistant 052 weld metal. Therefore, it would not be subject to PWSCC.*

2. On page of 5 of the Request under, "4. IWA-4500(e)(2)," Entergy states that the interpass temperature will not be measured because of the large heat sink provided by the pressurizer. Was this statement verified by calculations using the exact geometry and thicknesses for each weld repair type? If not, how can this statement be used to justify not performing any temperature measurement?

   Entergy's Response: *Entergy will use thermocouples and recording instruments when performing outside diameter (OD) weld pad repairs. These OD weld pad repairs are described in Section III.A of the relief request. However, Entergy cannot use thermocouples and recording instrumentation when performing heater sleeve mid-wall repairs. Because the inside diameters of the new sleeves are approximately 1.30 inches and welding is being performed internally, there is insufficient space and accessibility along the inside diameter of the heater sleeve to use thermocouples. As an alternative, Entergy will verify the preheat temperature with a pyrometer or temperature indicating crayon prior to welding. With respect to interpass temperature, Entergy will implement a five (5) minute hold time between passes to ensure that the interpass temperature will not approach 350°F. Mock-up testing and a supporting engineering analysis have been performed to demonstrate that the 350°F interpass temperature limitation of the code case will not be exceeded. See Reference 2 for specific details regarding the mock-up testing and engineering analysis. Entergy has also revised Section III.B.4 of W3-R&R-003 to reflect this additional information.*

3. On page of 5 of the Request under, "4. IWA-4500(e)(2)," Entergy states that, "the interpass temperature is not expected to approach 350° F. This was verified by mockup testing." Was the mockup thickness and geometry the same as the actual pressurizer part to be welded on? If not, justify how a mockup of different geometry and thickness can be used to justify not performing any temperature measurement.

   Entergy's Response: *Entergy will use thermocouples and recording instruments when performing OD weld pad repairs. These OD weld pad repairs are described in Section III.A of the relief request. However, regarding heater sleeve mid-wall repairs, mock-up testing and supporting engineering analysis have been performed by Welding Services, Inc. and Structural Integrity Associates to demonstrate that the 350°F interpass temperature limitation of the code case will not be exceeded by utilizing a five (5) minute hold time between passes. Specific details regarding the mock-up testing and engineering analysis are documented in WSI Bases Document,* Cooling Transients for Mid-Wall Weld Repairs, *which is provided in Reference 2 of this letter. Entergy has also revised Section III.B.4 of W3-R&R-003 to reflect this additional information.*

4. On page of 10 of the Request under, "B. 3.," Entergy states that, "The use of thermocouples and recording instruments is not required by ASME Section XI Code Case N-638 . . . " However, Code Case N-638 does require that all of the requirements of ASME Section XI be met. Therefore, please supplement your original application to indicate that Entergy will measure process temperatures in accordance with the requirements of IWA-4000, or provide a technical justification for not doing so.

   Also, since Code Case N-638 requires that all of the requirements of ASME Section XI IWA-4000 be met, please supplement your original application to indicate that Entergy will meet all of the other requirements of IWA-4000 that are not taken exception to in the code case.

   Entergy's Response: *Regarding the use of thermocouples and recording instruments, see the responses to Questions 2 and 3, above. Entergy has revised Section IV.B.3 of W3-R&R-003 to reflect this additional information. Entergy has also revised Section IV (Page 7) of W3-R&R-003 to clarify that all applicable requirements of IWA-4000 will be met except as otherwise approved by the NRC in accordance with this request.*

5. On page of 21 of Attachment 1 to the Request under, "4.0 EXAMINATION" Entergy does not require that non-destructive examination (NDE) be performed no sooner than 48 hours after welding has been completed and the weld has cooled to ambient temperature. This is not in accordance with Code Case N-638. Please supplement your original application to indicate that Entergy will perform all NDE no sooner than 48 hours after welding has been completed and the weld has cooled to ambient temperature or provide a technical justification for imposing alternate NDE requirements.

   Entergy's Response: *Entergy will perform NDE activities after the completed weld has been at ambient temperature for at least 48 hours. Sections 4.0(b) and (c) of Attachment 1 of W3-R&R-003 have been revised to reflect this requirement.*

ENCLOSURE 2

CNRO-2005-00014

REQUEST FOR ALTERNATIVE
W3-R&R-003

ENTERGY OPERATIONS, INC.
WATERFORD STEAM ELECTRIC STATION, UNIT 3
REQUEST FOR ALTERNATIVE
W3-R&R-003

I. COMPONENTS

Component/Number:	Pressurizer RC-MPZR-0001
Description:	Pressurizer Heater Sleeves Pressurizer Upper and Lower Head Instrument Nozzles Pressurizer Side Shell Nozzle
Code Class:	1
References:	1. ASME Section XI, 1992 Edition with portions of the 1993 Addenda as listed in Reference 7 2. ASME Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda 3. ASME Section III, Subsection NB, 1971 Edition, Summer 1972 Addenda 4. ASME Section III, Subsection NB, 1989 Edition 5. ASME Section XI Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique" 6. EPRI Report GC-111050, "Ambient Temperature Preheat for Machine GTAW Temper Bead Applications" 7. CEP-ISI-001, "Waterford 3 Steam Electric Station Inservice Inspection Plan" 8. Welding Services, Inc. Bases Document, *Cooling Transients for Mid-Wall Weld Repair*
Unit / Inspection Interval:	Waterford 3 Steam Electric Station (Waterford 3) / Second (2nd) 10-Year Interval

II. CODE REQUIREMENTS

Subarticle IWA-4170(b) of ASME Section XI, 1992 Edition states, "Repairs and installation of replacement items shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system. Later editions and Addenda of the Construction Code or of Section III, either in their entirety or portions thereof, and Code Cases may be used. If repair welding cannot be performed in accordance with these requirements, the applicable requirements of IWA-4200, IWA-4400, or IWA-4500 may be used."

IWA-4500 of ASME Section XI establishes alternative repair welding methods for performing temper bead welding. According to IWA-4500(a), "Repairs to base materials and welds identified in IWA-4510, IWA-4520, and IWA-4530 may be made by welding without the specified postweld heat treatment requirements of the Construction Code or Section III, provided the requirements of IWA-4500(a) through (e) and IWA-4510, IWA-4520, or IWA-4530, as applicable, are met."

IWA-4530 applies to dissimilar materials such as welds that join P-No. 43 nickel alloy to P-No. 3 low alloy steels. According to IWA-4530, "Repairs to welds that join P-No. 8 or P-No. 43 material to P-Nos. 1, 3, 12A, 12B, and 12C material may be made without the specified postweld heat treatment provided the requirements of IWA-4530 through IWA-4533 are met. Repairs made to this paragraph are limited to those along the fusion line of a nonferritic weld to ferritic base material where 1/8-inch or less of nonferritic weld deposit exists above the original fusion line after defect removal."

Temper bead repairs are performed in accordance with IWA-4500 and IWA-4530 whenever the repair cavity is within 1/8-inch of the ferritic base materials. When the gas tungsten arc welding (GTAW) process is used in accordance with IWA-4500 and IWA-4530, temper bead welding is performed as follows:

- Only the automatic or machine GTAW process using cold wire feed can be used. Manual GTAW cannot be used.
- A minimum preheat temperature of 300°F is established and maintained throughout the welding process. Interpass temperature cannot exceed 450°F.
- The weld cavity is buttered with at least six (6) layers of weld metal.
- Heat input of the initial six layers is controlled to within +/-10% of that used for the first six (6) layers during procedure qualification testing.
- After the first six weld layers, repair welding is completed with a heat input that is equal to or less than that used in the procedure qualification for weld layers seven and beyond.
- Upon completion of welding, a postweld soak or hydrogen bake-out at 450°F - 550°F for a minimum of four (4) hours is required.
- Preheat, interpass, and postweld soak temperatures are monitored using thermocouples and recording instruments.
- The repair weld and preheated band are examined in accordance with IWA-4533 after the completed weld has been at ambient temperature for 48 hours.

III. PROPOSED ALTERNATIVE

A. Background

The Waterford 3 pressurizer lower head, upper head, and side shell were manufactured from SA533, Grade B, Class 1 low alloy steel (P-Number 3, Group 3 material). The pressurizer heater sleeves, upper and lower head instrument nozzles, and side shell nozzle were originally manufactured from Alloy 600 material. Alloy 600 has a demonstrated sensitivity to primary water stress corrosion cracking (PWSCC).

During previous refueling outages, the Waterford 3 pressurizer upper head instrument nozzles were repaired by replacing the original Alloy 600 nozzles with new Alloy 690 nozzles. In addition, one of the thirty heater sleeves was also previous plugged using Alloy 690. During Refueling Outage 13 in the spring 2005, Waterford 3 will proactively replace all remaining Alloy 600 heater sleeves and instrument nozzles.

This request for alternative is specific to each of the following pressurizer repair welding activities that involve welding using a proposed ambient temperature temper bead technique:

- Heater Sleeve Mid-Wall Repair

  In this repair, the new Alloy 690 heater sleeve is welded directly to the pressurizer bore using the proposed ambient temperature temper bead process. Details of this repair are shown in Figure 1, Section "A-A" and Figure 2, Section "C-C".

- Heater Sleeve Repair Using an Outside Diameter Weld Pad

  In this repair, an Inconel weld pad is welded to the outside diameter (OD) of the pressurizer lower head using the proposed ambient temperature temper bead process. The new Alloy 690 heater sleeve is welded to the Inconel weld pad using a non-temper bead welding process. A typical detail of this repair is shown in Figure 2, Section "D-D". **Note:** This alternative repair option will only be used in the unlikely circumstance where the mid-wall repair cannot be implemented.

- OD Weld Pad Repair of Lower Head Instrument Nozzles

  In this repair, an Inconel weld pad is welded to the OD of the pressurizer lower head using the proposed ambient temperature temper bead process. The new Alloy 690 nozzle is welded to the Inconel weld pad using a non-temper bead welding process. A detail of this repair is shown in Figure 1, Section "B-B".

- OD Weld Pad Repair of Side Shell Instrument Nozzle

  In this repair, an Inconel weld pad is welded to the OD of the pressurizer side shell using the proposed ambient temperature temper bead process. The new Alloy 690 nozzle is welded to the Inconel weld pad using a non-temper bead welding process. A detail of this repair is shown in Figure 3.

- OD Weld Pad Repair of Previously Repaired Upper Head Instrument Nozzles

  Two Inconel 52 weld pads were previously welded to the OD of the pressurizer upper head using the temper bead process. Alloy 690 instrument nozzles were welded to the weld pads with Alloy 182 filler metal. In this repair, the existing nozzles and associated attachment welds will be removed by grinding and new Alloy 690 nozzles will be installed using Inconel 52 filler metal.

In the unlikely event that grinding results in a repair cavity that is within 1/8-inch of the ferritic base materials, ambient temperature temper bead welding will be performed. A typical detail of this repair is shown in Figure 4.

B. Proposed Alternative

Pursuant to 10 CFR 50.55a(a)(3)(i), Entergy proposes alternatives to the GTAW-machine temper bead welding requirements of IWA-4500 and IWA-4530 of ASME Section XI. Specifically, Entergy proposes to perform ambient temperature temper bead welding in accordance with Attachment 1, "Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique."

Entergy will use this proposed alternative for mid-wall repairs of the pressurizer heater sleeves and OD weld pad repairs of the pressurizer instrument nozzles as described in Section III.A above. However, where mid-wall repairs for pressurizer heater sleeves cannot be performed, an alternative OD weld pad repair will be performed. Although a contingency, this alternative OD weld pad repair for the heater sleeves is unlikely.

Entergy has reviewed the proposed ambient temperature temper bead welding techniques of Attachment 1 against the GTAW-machine temper bead welding requirements of IWA-4500 and IWA-4530. This review was performed to identify differences between Attachment 1 and IWA-4500 and IWA-4530. Based upon this review, Entergy proposes alternatives to the following ASME Section XI requirements of IWA-4500 and IWA-4530:

1. **IWA-4500(a)** specifies that repairs to base materials and welds identified in IWA-4530 may be performed without the specified postweld heat treatment of the construction code or ASME Section III provided the requirements of IWA-4500 and IWA-4530 are met. IWA-4530 includes temper bead requirements applicable to the shielded metal arc welding (SMAW) and the machine or automatic GTAW processes. As an alternative, Entergy proposes to perform temper bead weld repairs using the ambient temperature temper bead technique described in Attachment 1. Only the machine or automatic GTAW process can be used when performing ambient temperature temper bead welding in accordance with Attachment 1.

2. **IWA-4500(d)(2)** specifies that if repair welding is to be performed where physical obstructions impair the welder's ability to perform, the welder shall also demonstrate the ability to deposit sound weld metal in the positions, using the same parameters and simulated physical obstructions as are involved in the repair. This limited accessibility demonstration applies when manual temper bead welding is performed using the Shielded Metal Arc Welding (SMAW) process. It does not apply to "welding operators" who perform machine or automatic GTAW welding from a remote location. (This distinction is clearly made in IWA-4500 and IWA-4530.) Because the proposed ambient temperature temper bead technique described in Attachment 1 utilizes a machine GTAW welding process, limited access demonstrations of "welding operators" are not required. Therefore, the requirement of IWA-4500(d)(2) does not apply.

3. **IWA-4500(e)(2)** specifies that the weld area plus a band around the repair area of at least 1½ times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 300°F for the GTAW process during welding; maximum interpass temperature shall be 450°F. As an alternative, Entergy proposes that the weld area plus a band around the repair area of at least 1½ times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 50°F for the GTAW process during welding. The maximum interpass temperature shall be 350°F regardless of the interpass temperature during qualification.

4. **IWA-4500(e)(2)** specifies that thermocouples and recording instruments shall be used to monitor process temperatures. Entergy will use thermocouples and associated recording instruments when performing an OD pad repair. However, Entergy cannot use thermocouples and recording instrumentation when performing a mid-wall repair. Because the inside diameter of the new sleeve is only 1.30 inches (approximately) and welding is being performed internally, there is insufficient space and accessibility along the inside diameter of the heater sleeve to use thermocouples. As an alternative, Entergy will verify the preheat temperature with a pyrometer or temperature indicating crayon prior to welding. With respect to interpass temperature, Entergy will implement a five (5) minute hold time between passes to ensure that the interpass temperature will not approach 350°F. Mock-up testing and supporting engineering analysis (Reference 8) have been performed to demonstrate that the 350°F interpass temperature limitation of the code case will not be exceeded.

5. **IWA-4500(e)(2)** specifies that thermocouple attachment and removal shall be performed in accordance with ASME Section III. Because Entergy will not use thermocouples, the thermocouple attachment and removal requirements of IWA-4500(e)(2) do not apply.

6. **IWA-4532.1** establishes procedure technique requirements that apply when using the SMAW process. Because the proposed ambient temperature temper bead technique of Attachment 1 utilizes the machine or automatic GTAW welding process, the SMAW temper bead technique requirements of paragraph IWA-4532.1 do not apply.

7. **IWA-4532.2(c)** specifies that the repair cavity shall be buttered with six layers of weld metal in which the heat input of each layer is controlled to within +/-10% of that used in the procedure qualification test, and heat input control for subsequent layers shall be deposited with a heat input equal to or less than that used for layers beyond the sixth in the procedure qualification. As an alternative, Entergy proposes to deposit the weld area with a minimum of three layers of weld metal to obtain a minimum thickness of 1/8-inch. The heat input of each weld layer in the 1/8-inch thick section shall be controlled to within +/-10% of that used in the procedure qualification test. The heat input for subsequent weld layers shall not exceed the heat input used for layers beyond the 1/8-inch thick buttered section (first three weld layers) in the procedure qualification.

8. **IWA-4532.2(c)** specifies that the completed weld shall have at least one layer of weld reinforcement deposited. Once the weld is completed, this reinforcement shall be removed by mechanical means. As an alternative, Entergy's proposed ambient temperature temper bead technique does not include a reinforcement layer.

9. **IWA-4532.2(d)** specifies that, after at least 3/16-inch of weld metal has been deposited, the weld area shall be maintained at a temperature of 450°F - 550°F for a minimum of four (4) hours (for P-No. 3 materials). As an alternative, Entergy's proposed ambient temperature temper bead technique does not include a postweld soak.

10. **IWA-4532.2(e)** specifies that after depositing at least 3/16-inch of weld metal and performing a postweld soak 450°F - 550°F, the balance of welding may be performed at an interpass temperature of 350°F. As an alternative, Entergy proposes that an interpass temperature of 350°F may be used throughout the welding process without a postweld soak.

11. **IWA-4533** specifies the following examinations shall be performed after the completed repair weld has been at ambient temperature for at least 48 hours: (a) the repair weld and preheated band shall be examined by the liquid penetrant method; (b) the repaired region shall be volumetrically examined by the radiographic method, and if practical, by the ultrasonic method. As an alternative to the IWA-4533, Entergy proposes to perform the following examinations of the new mid-wall repair weld and OD weld pad after the completed repair weld has been at ambient temperature for 48 hours:

    a. A liquid penetrant examination of the completed repair weld shall be performed in accordance with NB-5000 of ASME Section III, 1989 Edition. Acceptance criteria shall comply with NB-5350.

    b. The completed repair weld shall be ultrasonically examined in accordance with NB-5000 of ASME Section III, 1989 Edition. Acceptance criteria shall comply with NB-5330.

IV. <u>BASIS FOR PROPOSED ALTERNATIVE</u>

The pressurizer upper and lower heads and side shell were manufactured from P-No. 3, Group 3 low alloy steel. If repairs were to be performed in accordance with ASME Section III, Entergy would have two options:

1. Perform a weld repair that includes a postweld heat treatment at 1,100°F – 1,250°F in accordance with NB-4622.1; or

2. Perform a temper bead repair using the SMAW process in accordance with NB-4622.11.

Each option is discussed below.

1. <u>Postweld Heat Treatment</u>

NB-4600 requires postweld heat treatment (PWHT) to be performed at 1,100°F – 1,250°F. PWHT of the pressurizer head is impractical as it could cause ovalization and misalignment of heater sleeves, which would permanently damage the head including the heater support assembly.

2. Temper Bead Repair Using SMAW

NB-4622.11 provides temper bead rules for repair welding dissimilar materials using the SMAW process. Because NB-4622.11 does not include temper bead rules for the machine or automatic GTAW process, a manual SMAW temper bead process must be used. However, a manual SMAW temper bead repair is not a desirable option due to radiological considerations. First, resistance heating blankets, thermocouples, and insulation must be installed. Secondly, the manual SMAW temper bead process is a time and dose intensive process. Each weld layer is manually deposited in a high dose and high temperature (350°F) environment. The manual SMAW process also requires the weld crown of the first weld layer to be mechanically removed by grinding. Upon completing repair welding, the resistance heating blankets, thermocouples, and insulation must be removed. Thermocouples and heating blanket-mounting pins must be removed by grinding. The ground areas must be subsequently examined by either magnetic particle or liquid penetrant examination techniques.

Entergy is not requesting an alternative to NB-4600; rather this request proposes an alternative to IWA-4500 and IWA-4530. Owners are allowed by ASME Section XI IWA-4170(b) and IWA-4500(a) to perform temper bead repairs of dissimilar materials. IWA-4170(b) and IWA-4500(a) provide requirements and controls for performing such repairs. For clarification, Entergy will meet applicable requirements of IWA-4000 except as otherwise approved by the NRC in accordance with this request.

IWA-4500 and IWA-4530 of ASME Section XI establish requirements for performing temper bead welding of "dissimilar materials". According to IWA-4530, either the automatic or machine GTAW process or SMAW process may be used. When using the machine GTAW process, a minimum preheat temperature of 300°F must be established and maintained throughout the welding process while the interpass temperature is limited to 450°F. Upon completion of welding, a postweld soak is performed at 450°F - 550°F for a minimum of 4 hours.

The IWA-4500 and IWA-4530 temper bead welding process is a time and dose intensive process. Resistance heating blankets are attached to the pressurizer base material; typically a capacitor discharge stud welding process is used. Thermocouples must also be attached to the pressurizer base material using a capacitor discharge welding process to monitor preheat, interpass, and postweld soak temperatures. Prior to heatup, thermal insulation is also installed. Upon completion of repair welding (including the postweld soak), the insulation, heating blankets, studs, and thermocouples must be removed from the pressurizer base material. Thermocouples and stud welds are removed by grinding. Ground removal areas are subsequently examined by the liquid penetrant or magnetic particle method. A significant reduction in dose could be realized by utilizing an ambient temperature temper bead process. Therefore, Entergy proposes an alternative welding technique based on the methodology of ASME Code Case N-638.

Suitability of Proposed Ambient Temperature Temper Bead Technique

A. Evaluation of the Ambient Temperature Temper Bead Technique

Research by the Electric Power Research Institute (EPRI) and other organizations on the use of an ambient temperature temper bead operation using the machine GTAW process is documented in EPRI Report GC-111050. According to the EPRI report, repair welds performed with an ambient temperature temper bead procedure utilizing the machine GTAW welding process exhibit mechanical properties equivalent or better than those of the surrounding base material. Laboratory testing, analysis, successful procedure qualifications, and successful repairs have all demonstrated the effectiveness of this process.

The effects of the ambient temperature temper bead welding process of Attachment 1 on mechanical properties of repair welds, hydrogen cracking, and restraint cracking are addressed below.

1. Mechanical Properties

The principal reasons to preheat a component prior to repair welding is to minimize the potential for cold cracking. The two cold cracking mechanisms are hydrogen cracking and restraint cracking. Both of these mechanisms occur at ambient temperature. Preheating slows down the cooling rate resulting in a ductile, less brittle microstructure thereby lowering susceptibility to cold cracking. Preheat also increases the diffusion rate of monatomic hydrogen that may have been trapped in the weld during solidification. As an alternative to preheat, the ambient temperature temper bead welding process utilizes the tempering action of the welding procedure to produce tough and ductile microstructures. Because precision bead placement and heat input control is characteristic of the machine GTAW process, effective tempering of weld heat affected zones is possible without the application of preheat. According to Section 2-1 of EPRI Report GC-111050, "[T]he temper bead process is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered heat affected zone such that the desired degree of carbide precipitation (tempering) is achieved. The resulting microstructure is very tough and ductile."

The IWA-4530 temper bead process also includes a postweld soak requirement. Performed at 450°F - 550°F for 4 hours (P-No. 3 base materials), this postweld soak assists diffusion of any remaining hydrogen from the repair weld. As such, the postweld soak is a hydrogen bake-out and not a postweld heat treatment as defined by the ASME Code. At 450°F - 550°F, the postweld soak does not stress relieve, temper, or alter the mechanical properties of the weldment in any manner.

Section 2.1 of Attachment 1 establishes detailed welding procedure qualification requirements for base materials, filler metals, restrain, impact properties, and other procedure variables. The qualification requirements of Section 2.1 provide assurance that the mechanical properties of repair welds will be equivalent or superior to those of the surrounding base material.

2. Hydrogen Cracking

Hydrogen cracking is a form of cold cracking. It is produced by the action of internal tensile stresses acting on low toughness heat affected zones. The internal stresses are produced from localized build-ups of monatomic hydrogen. Monatomic hydrogen forms when moisture or hydrocarbons interact with the welding arc and molten weld pool. The monatomic hydrogen can be entrapped during weld solidification and tends to migrate to transformation boundaries or other microstructure defect locations. As concentrations build, the monatomic hydrogen will recombine to form molecular hydrogen – thus generating localized internal stresses at these internal defect locations. If these stresses exceed the fracture toughness of the material, hydrogen induced cracking will occur. This form of cracking requires the presence of hydrogen and low toughness materials. It is manifested by intergranular cracking of susceptible materials and normally occurs within 48 hours of welding.

IWA-4500 establishes elevated preheat and postweld soak requirements. The elevated preheat temperature of 300°F increases the diffusion rate of hydrogen from the weld. The postweld soak at 450°F - 550°F was also established to bake-out or facilitate diffusion of any remaining hydrogen from the weldment. However, while hydrogen cracking is a concern for SMAW, which uses flux covered electrodes, the potential for hydrogen cracking is significantly reduced when using the machine GTAW welding.

The machine GTAW welding process is inherently free of hydrogen. Unlike the SMAW process, GTAW welding filler metals do not rely on flux coverings that may be susceptible to moisture absorption from the environment. Conversely, the GTAW process utilizes dry inert shielding gases that cover the molten weld pool from oxidizing atmospheres. Any moisture on the surface of the component being welded will be vaporized ahead of the welding torch. The vapor is prevented from being mixed with the molten weld pool by the inert shielding gas that blows the vapor away before it can be mixed. Furthermore, modern filler metal manufacturers produce wires having very low residual hydrogen. This is important because filler metals and base materials are the most realistic sources of hydrogen for automatic or machine GTAW temper bead welding. Therefore, the potential for hydrogen-induced cracking is greatly reduced by using the machine GTAW process.

3. Cold Restraint Cracking

Cold restraint cracking generally occurs during cooling at temperatures approaching ambient temperature. As stresses build under a high degree of restraint, cracking may occur at defect locations. Brittle microstructures with low ductility are subject to cold restraint cracking. However, the ambient temperature temper bead process is designed to provide a sufficient heat inventory so as to produce the desired tempering for high toughness. Because the machine GTAW temper bead process provides precision bead placement and control of heat, the toughness and ductility of the heat affected zone will typically be superior to the base material. Therefore, the resulting structure will be appropriately tempered to exhibit toughness sufficient to resist cold cracking.

In conclusion, no elevated preheat or postweld soak above ambient temperature is required to achieve sound and tough repair welds when performing ambient temperature temper bead welding using the machine GTAW process. This conclusion is based upon strong evidence that hydrogen cracking will not occur with the GTAW process. In addition, automatic or machine temper bead welding procedures without preheat will produce satisfactory toughness and ductility properties both in the weld and weld heat affected zones. The results of previous industry qualifications and repairs further support this conclusion. The use of an ambient temperature temper bead welding procedure will improve the feasibility of performing localized weld repairs with a significant reduction in radiological exposure.

B. Evaluation of Proposed Alternatives to IWA-4500 and IWA-4530

1. According to **IWA-4500(a)**, repairs may be performed to dissimilar base materials and welds without the specified postweld heat treatment of ASME Section III provided the requirements of IWA-4500 and IWA-4530 are met. The temper bead rules of IWA-4500 and IWA-4530 apply to dissimilar materials such as P-No. 43 to P-No. 3 base materials welded with F-No. 43 filler metals. When using the GTAW-machine process, the IWA-4500 and IWA-4530 temper bead process is based fundamentally on an elevated preheat temperature of 300°F, a maximum interpass temperature of 450°F, and a postweld soak of 450°F - 550°F. The proposed alternative of Attachment 1 also establishes requirements to perform temper bead welding on dissimilar material welds that join P-No. 43 to P-No. 3 base materials using F-No. 43 filler metals. However, the temper bead process of Attachment 1 is an ambient temperature technique that only utilizes the GTAW-machine or GTAW-automatic process. The suitability of the proposed ambient temperature temper bead technique is evaluated in this section. The results of this evaluation demonstrate that the proposed ambient temperature temper bead technique provides an acceptable level of quality and safety.

2. According to **IWA-4500(e)(2)**, the weld area plus a band around the repair area of at least 1½ times the component thickness or 5 inches, whichever is less, shall be preheated and maintained at a minimum temperature of 300°F for the GTAW process during welding while the maximum interpass temperature is limited to 450°F. The ambient temperature temper bead technique of Attachment 1 also establishes a preheat band of at least 1½ times the component thickness or 5 inches, whichever is less. However, the ambient temperature temper bead technique requires a minimum preheat temperature of 50°F and a maximum interpass temperature of 350°F. The suitability of an ambient temperature temper bead technique with reduced preheat and interpass temperatures is addressed in Section IV.A.

3. According to **IWA-4500(e)(2)**, thermocouples and recording instruments shall be used to monitor process temperatures. As explained in Section III.B, Entergy will use thermocouples and associated recording instruments when performing an OD pad repair. However, Entergy cannot use thermocouples

and recording instrumentation while performing a mid-wall repair. Because the inside diameter of the new sleeve is only 1.30 inches (approximately) and welding is being performed internally, there is insufficient space and accessibility along the inside diameter of the heater sleeve to use thermocouples. As an alternative, Entergy will verify the preheat temperature with a pyrometer or temperature indicating crayon prior to welding. With respect to interpass temperature, Entergy will implement a five (5) minute hold time between passes to ensure that the interpass temperature will not approach 350°F. Because of the large heat sink of the pressurizer and the five-minute hold time between passes, the 350°F interpass limitation of the welding procedure will not be exceeded. Mock-up testing and supporting engineering analysis (Reference 8) have been performed by Welding Services, Inc. and Structural Integrity Associates to support this position. This alternative approach for controlling interpass temperature has been approved by the NRC for performing mid-wall repairs of reactor pressure vessel head nozzles at Arkansas Nuclear One Unit 1, Calvert Cliffs Units 1 and 2, Millstone Unit 2, Oconee Units 1 and 2, Palisades, and Point Beach Units 1 and 2.

4. According to **IWA-4532.2(c)**, the repair cavity shall be buttered with six layers of weld metal in which the heat input of each layer is controlled to within +/-10% of that used in the procedure qualification test, and heat input control for subsequent layers shall be deposited with a heat input equal to or less than that used for layers beyond the sixth in the procedure qualification. As an alternative to IWA-4532.2, Entergy proposes to butter the ferritic base material with at least three layers of weld metal to obtain a minimum butter thickness of 1/8-inch. The heat input of each layer in the 1/8-inch thick buttered section shall be controlled to within +/-10% of that used in the procedure qualification test. The heat input for subsequent weld layers shall not exceed the heat input used for layers beyond the 1/8-inch thick buttered section (first three weld layers) in the procedure qualification. When using the ambient temperature temper bead technique of Attachment 1, the machine GTAW process is used. Machine GTAW is a low heat input process that produces consistent small volume heat affected zones. Subsequent GTAW weld layers introduce heat into the heat affected zone produced by the initial weld layer. The heat penetration of subsequent weld layers is carefully applied to produce overlapping thermal profiles that develop a correct degree of tempering in the underlying heat affected zone. When welding dissimilar materials with nonferritic weld metal, the area requiring tempering is limited to the weld heat affected zone of the ferritic base material along the ferritic fusion line.

   After welding the ferritic base material to Alloy 690 with at least 1/8-inch of weld metal (first 3 weld layers), subsequent weld layers should not provide any additional tempering to the weld heat affected zone in the ferritic base material. Therefore, less restrictive heat input controls are adequate after depositing the 1/8-inch thick weld section.

5. According to **IWA-4532.2(c)**, at least one layer of weld reinforcement shall be deposited on the completed weld and with this reinforcement being subsequently removed by mechanical means. In the proposed alternative of Attachment 1, the deposition and removal of a reinforcement layer is not required. A reinforcement layer is required when a weld repair is performed to

a ferritic base material or ferritic weld using a ferritic weld metal. On ferritic materials, the weld reinforcement layer is deposited to temper the last layer of untempered weld metal of the completed repair weld. Because the weld reinforcement layer is untempered (and unnecessary), it is removed. However, when repairs are performed to dissimilar materials using nonferritic weld metal, a weld reinforcement layer is not required because nonferritic weld metal does not require tempering. When performing a dissimilar material weld with a nonferritic filler metal, the only location requiring tempering is the weld heat affected zone in the ferritic base material along the weld fusion line. However, the three weld layers of the 1/8-inch thick weld section are designed to provide the required tempering to the weld heat affected zone in the ferritic base material. Therefore, a weld reinforcement layer is not required.

While Entergy recognizes that IWA-4532.2(c) does require the deposition and removal of a reinforcement layer on repair welds in dissimilar materials, Entergy does not believe that it is necessary for repair using a nonferritic filler material. This position is supported by the fact that ASME Code Case N-638 only requires the deposition and removal of a reinforcement layer of a similar filler material (ferritic) when performing repair welds on similar (ferritic) materials. Repair welds on dissimilar materials using nonferritic filler materials are exempt from this requirement in Code Case N-638.

6. According to **IWA-4532.2(d)**, the weld area shall be maintained at a temperature of 450°F - 550°F for a minimum of 4 hours (for P-No. 3 materials) after at least 3/16-inch of weld metal has been deposited. In the proposed alternative of Attachment 1, a postweld soak is not required. The suitability of an ambient temperature temper bead technique without a postweld soak is addressed in Section IV.A.

7. According to **IWA-4532.2(e)**, after depositing at least 3/16-inch of weld metal and performing a postweld soak at 300°F, the balance of welding may be performed at an interpass temperature of 350°F. As an alternative, Entergy proposes that an interpass temperature of 350°F may be used throughout the welding process without a postweld soak. The proposed ambient temperature temper bead process of Attachment 1 is carefully designed and controlled such that successive weld beads supply the appropriate quantity of heat to the untempered heat affected zone such that the desired degree of carbide precipitation (tempering) is achieved. The resulting microstructure is very tough and ductile. This point is validated during weld procedure qualification. Based on Charpy V-notch testing of the procedure qualification test coupon, impact properties in weld heat affected zone will be demonstrated to be equal to or better than those of the unaffected base material. The suitability of an ambient temperature temper bead technique without a postweld soak is addressed in Section IV.A.

8. **IWA-4533** specifies that (a) the repair weld and preheated band shall be examined by the liquid penetrant method; (b) the repaired region shall be volumetrically examined by the radiographic method, and if practical, by the ultrasonic method. As an alternative to the IWA-4533, Entergy proposes to perform the following examinations after the completed repair weld has been at ambient temperature for 48 hours:

   a. Liquid penetrant examination shall be performed in accordance with NB-5000 of ASME Section III, 1989 Edition. Acceptance criteria shall comply with NB-5350.

      Suitability: When using an ambient temperature temper bead technique, an elevated preheat temperature is not used. As a result, there is no preheated band. Therefore, the proposed alternative to only examine the new mid-wall repair weld and OD weld pad (including weld heat affected zones) is acceptable.

   b. The completed repair weld shall be ultrasonically examined in accordance with NB-5000 of ASME Section III, 1989 Edition. Acceptance criteria shall comply with NB-5330.

      Suitability: Radiographic examination is impractical since the pressurizer vessel inside diameter is inaccessible for positioning the gamma source. As an alternative to radiographic examination, an ultrasonic examination of the new mid-wall repair weld and OD weld pad will be performed. Ultrasonic examination of temper bead repair welds is an acceptable option according to ASME Section XI, IWA-4630 in the 1995 Edition, 1996 Addenda and later (approved by NRC through the 2001 Edition, 2003 Addenda). Ultrasonic examination of repair welds is also required in Code Case N-638. The proposed ultrasonic examination will be performed in accordance with ASME Section III, NB-5000 which includes acceptance criteria that is appropriate for fabrication type flaws.

V. <u>CONCLUSION</u>

10 CFR 50.55a(a)(3) states:

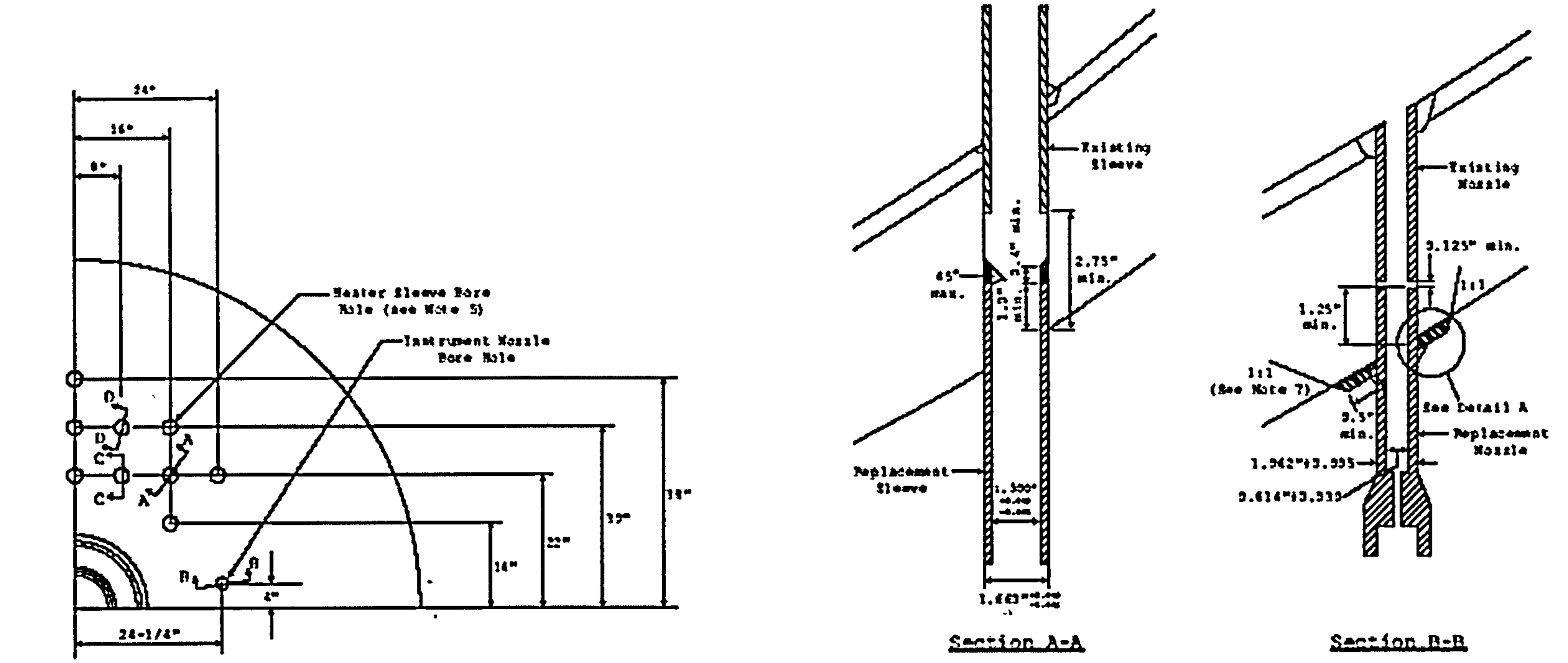
"Proposed alternatives to the requirements of (c), (d), (e), (f), (g), and (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation. The applicant shall demonstrate that:

(i) The proposed alternatives would provide an acceptable level of quality and safety, or

(ii) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Entergy believes that compliance with the repair rules as stated in ASME Section XI (Reference 1) and as described in Section II of this request would result in unwarranted damage to the pressurizer head assembly. Additionally, the work required to meet the current Code repair method, automatic or machine GTAW temper bead with 300°F minimum preheat and 450°F - 550°F postweld hydrogen bake-out, would be extremely difficult and personnel radiation exposure resulting from set-up, monitoring, and removing the required equipment is not justified.

Entergy also believes that the proposed alternative provides an acceptable level of quality and safety without exposing the pressurizer to potential distortion of the sleeves and heater support structure, as discussed in Section IV. Therefore, Entergy requests that the NRC staff authorize the proposed alternative in accordance with 10 CFR 50.55a(a)(3)(i).



Notes:
1. Break all sharp corners to leave a smooth transition.
2. Replacement sleeves and nozzles are Alloy 690 material.
3. Replacement weld metal is Alloy 52/152.
4. Replacement sleeve and nozzle length defined by WSI.
5. Potential MNSA/mid-wall repair interaction shown on Sheet 2 of 2.
6. There is no requirement as to the radius of the replacement weld connecting the pad to the replacement nozzle/sleeve.
7. The slope of the replacement weld shown is a maximum slope. Other slopes, such as 1:3 where the first dimension is the pad thickness, are acceptable.
8. MNSA holes will not be plugged.

Structural Integrity Associates, Inc.

TITLE: Pressurizer Bottom Head Heater Sleeve/Instrument Nozzle Repairs
Waterford Steam Electric Station, Unit 3

Drawn by: B. Carney	Date:	Drawing No. 04139r0	Project No. WSES-10Q	
Checked by: R. Mattson	Date:	Nuclear Safety Related: YES [X] NO [ ]	File No. WSES-10Q-501	
Engineer: R. Bax	Date:			
Approved by: R. Mattson	Date:	Code: ASME, III, NB CONSTRUCTION ONLY	Scale: None	Sheet: 1 of 2 / Rev: 0

Figure 1

Sections Showing Heater Sleeve and Instrument Repair

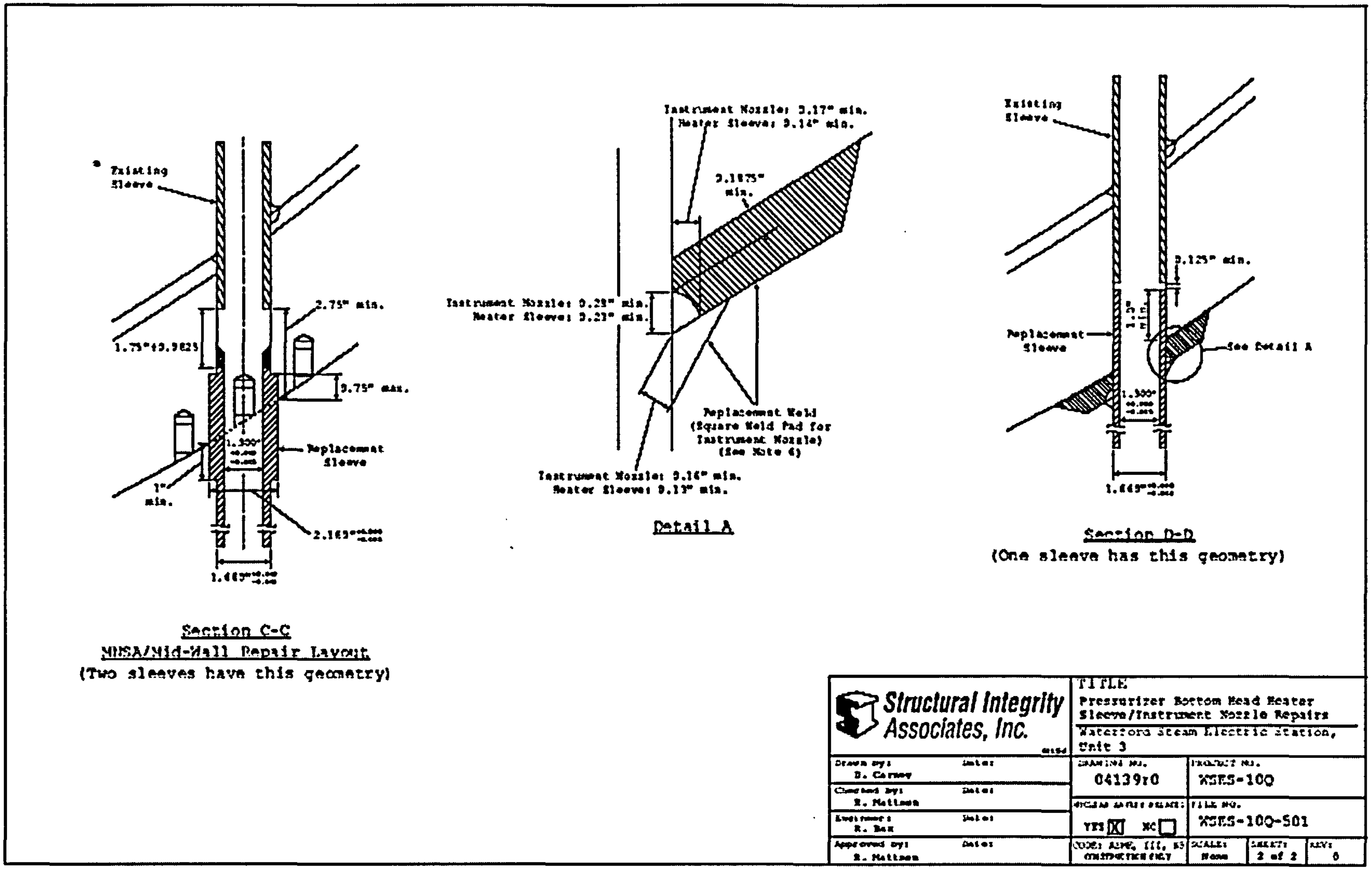
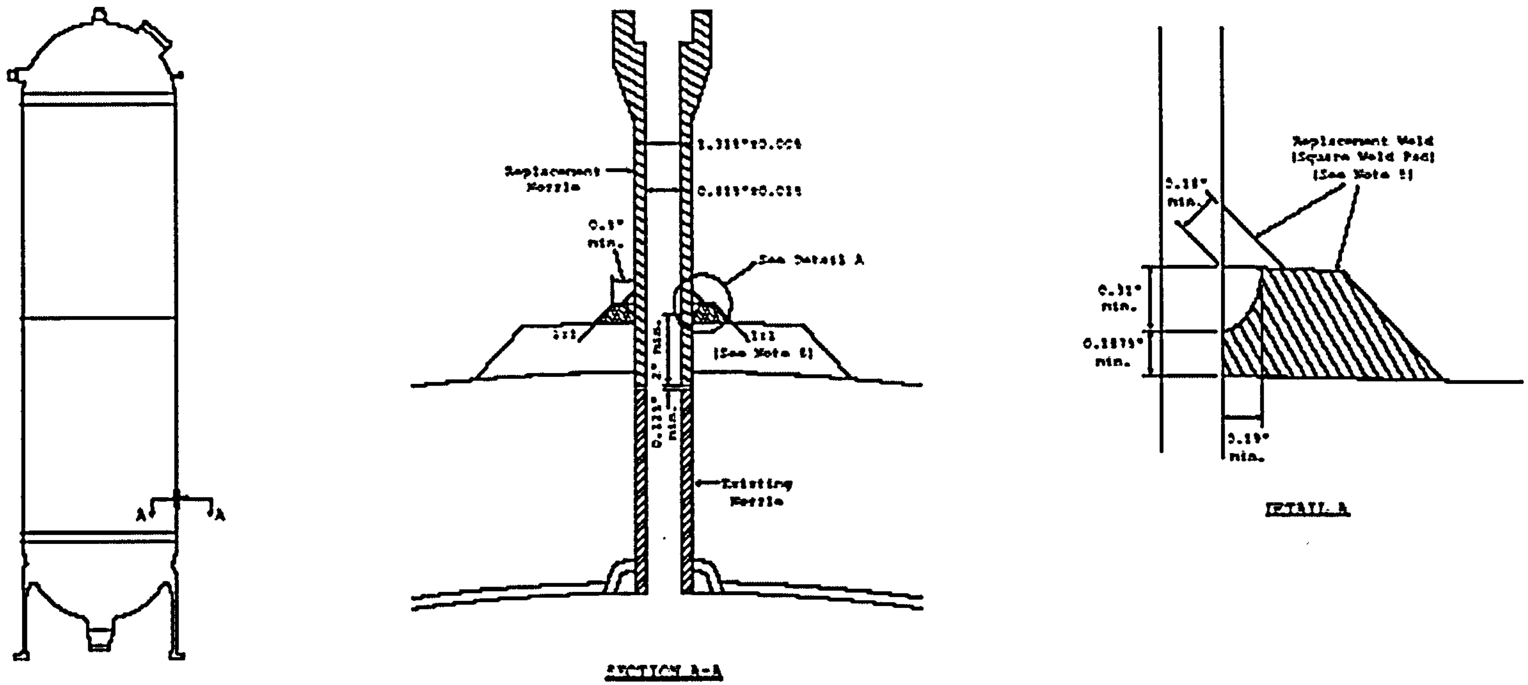


Figure 2

Sections Showing Heater Sleeve and Instrument Repairs at Previous MNSA and OD Pad Locations



Notes:
1. Break all sharp corners to leave a smooth transition.
2. Replacement nozzle is Alloy 690 material.
3. Replacement weld metal is Alloy 52/152.
4. Replacement nozzle length defined by WSI.
5. There is no requirement as to the radius of the replacement weld connecting the pad to the replacement nozzle.
6. The slope of the replacement weld shown is a maximum slope. Other slopes, such as 1:3 where the first dimension is the pad thickness, are acceptable.

Structural Integrity Associates, Inc.

TITLE: Pressurizer Side Shell Instrument Nozzle Repair
Waterford Steam Electric Station, Unit 3

Drawn By: D. Casey
Checked By: R. Mattson
Engineer: A. Das
Approved By: R. Mattson

04152r0
WSFS-10Q
Nuclear Safety Related: YES [X] NO [ ]
File No.: WSFS-10Q-501
CODE: ASME, III, NC CONSTRUCTION ONLY
Scale: None
Sheet: 1 of 1
Rev: 0

Figure 3

Section Showing Side Wall Instrument Repair

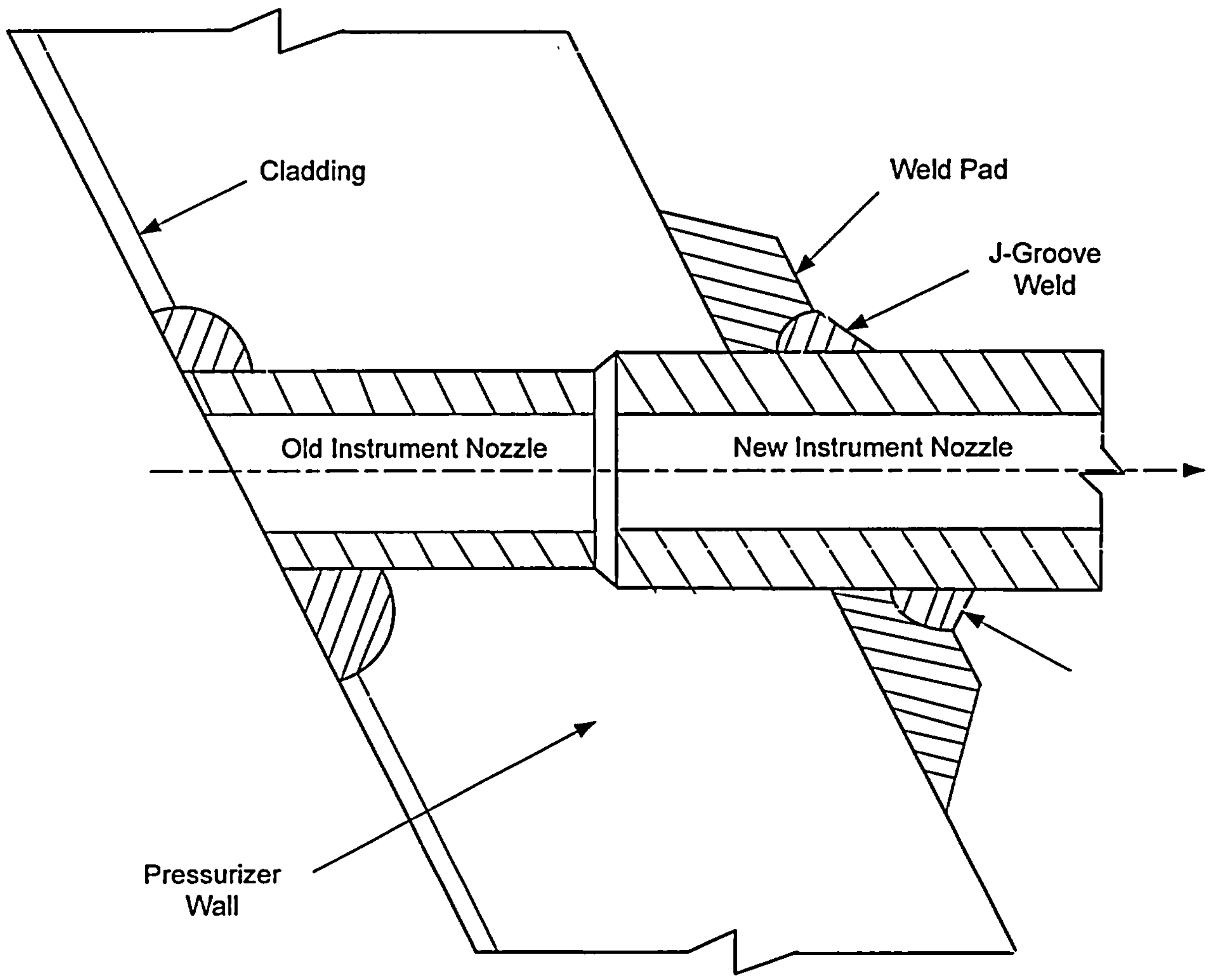


Figure 4

Pressurizer Upper Head Instrument Nozzle Repair

REQUEST NO. W3-R&R-003

ATTACHMENT 1

DISSIMILAR METAL WELDING USING AMBIENT TEMPERATURE MACHINE GTAW TEMPER BEAD TECHNIQUE

1.0 GENERAL REQUIREMENTS:

(a) The maximum area of an individual weld based on the finished surface will be less than 100 square inches, and the depth of the weld will not be greater than one-half of the ferritic base metal thickness.

(b) Repair/replacement activities on a dissimilar-metal weld are limited to those along the fusion line of a nonferritic weld to ferritic base material on which 1/8-inch or less of nonferritic weld deposit exists above the original fusion line. Repair/replacement activities on nonferritic base materials where the repair cavity is within 1/8-inch of a ferritic base material may also be performed.

(c) If a defect penetrates into the ferritic base material, repair of the base material, using a nonferritic weld filler material, may be performed provided the depth of repair in the base material does not exceed 3/8-inch.

(d) Prior to welding, the temperature of the area to be welded and a band around the area of at least 1½ times the component thickness (or 5 inches, whichever is less) will be at least 50°F.

(e) Welding materials will meet the Owner's Requirements and the Construction Code and Cases specified in the repair/replacement plan. Welding materials will be controlled so that they are identified as acceptable until consumed.

(f) The area prepared for welding shall be suitably prepared for welding in accordance with a written procedure.

2.0 WELDING QUALIFICATIONS

The welding procedures and the welding operators shall be qualified in accordance with Section IX and the requirements of paragraphs 2.1 and 2.2.

2.1 Procedure Qualification:

(a) The base materials for the welding procedure qualification will be the same P-Number and Group Number as the materials to be welded. The materials shall be post weld heat treated to at least the time and temperature that was applied to the material being welded.

(b) Consideration will be given to the effects of irradiation on the properties of material, including weld material for applications in the core belt line region of the reactor vessel. Special material requirements in the Design Specification will also apply to the test assembly materials for these applications.

(c) The root width and included angle of the cavity in the test assembly will be no greater than the minimum specified for the repair.

(d) The maximum interpass temperature for the first three layers or as required to achieve the 1/8-inch butter thickness in the test assembly will be 150°F. For the balance of the welding, the maximum interpass temperature shall be 350°F.

(e) The test assembly cavity depth will be at least one-half the depth of the weld to be installed during the repair/replacement activity, and at least 1 inch. The test assembly thickness will be at least twice the test assembly cavity depth. The test assembly will be large enough to permit removal of the required test specimens. The test assembly dimensions surrounding the cavity will be at least the test assembly thickness, and at least 6 inches. The qualification test plate will be prepared in accordance with Figure 1.

(f) Ferritic base material for the procedure qualification test will meet the impact test requirements of the Construction Code and Owner's Requirements. If such requirements are not in the Construction Code and Owner's Requirements, the impact properties shall be determined by Charpy V-notch impact tests of the procedure qualification base material at or below the lowest service temperature of the item to be repaired. The location and orientation of the test specimens shall be similar to those required in subparagraph (h) below, but shall be in the base metal.

(g) Charpy V-notch tests of the ferritic weld metal of the procedure qualification shall meet the requirements as determined in subparagraph (f) above. This test is not required when non-ferritic weld metal is used.

(h) Charpy V-notch tests of the ferritic heat-affected zone (HAZ) will be performed at the same temperature as the base metal test of subparagraph (f) above. Number, location, and orientation of test specimens will be as follows:

1. The specimens will be removed from a location as near as practical to a depth of one-half the thickness of the deposited weld metal. The test coupons for HAZ impact specimens will be taken transverse to the axis of the weld and etched to define the HAZ. The notch of the Charpy V-notch specimens will be cut approximately normal to the material surface in such a manner as to include as much HAZ as possible in the resulting fracture. When the material thickness permits, the axis of a specimen will be inclined to allow the root of the notch to be aligned parallel to the fusion line.

2. If the test material is in the form of a plate or a forging, the axis of the weld will be oriented parallel to the principal direction of rolling or forging.

3. The Charpy V-notch test will be performed in accordance with SA-370. Specimens will be in accordance with SA-370, Figure 11, Type A. The test will consist of a set of three full-size 10 mm x 10 mm specimens. The lateral expansion, percent shear, absorbed energy, test temperature, orientation and location of all test specimens will be reported in the Procedure Qualification Record.

(i) The average values of the three HAZ impact tests will be equal to or greater than the average values of the three unaffected base metal tests.

2.2 Performance Qualification:

Welding operators will be qualified in accordance with ASME Section IX.

3.0 WELDING PROCEDURE REQUIREMENTS:

The welding procedure shall include the following requirements:

(a) The weld metal shall be deposited by the automatic or machine GTAW process using cold wire feed.

(b) Dissimilar metal welds shall be made using F-No. 43 weld metal (QW-432) for P-No. 43 to P-No. 3 weld joints.

(c) The area to be welded will be buttered with a deposit of at least three layers to achieve at least 1/8-inch butter thickness as shown in Figure 2, steps 1 through 3, with the heat input for each layer controlled to within ± 10% of that used in the procedure qualification test. Particular care will be taken in placement of the weld layers at the weld toe area of the ferritic base material to ensure that the HAZ is tempered. Subsequent layers will be deposited with a heat input not exceeding that used for layers beyond the third layer (or as required to achieve the 1/8-inch butter thickness) in the procedure qualification.

(d) The maximum interpass temperature field applications will be 350°F regardless of the interpass temperature during qualification.

(e) Particular care will be given to ensure that the weld region is free of all potential sources of hydrogen. The surfaces to be welded, filler metal, and shielding gas shall be suitably controlled.

4.0 EXAMINATION:

(a) Prior to welding, a surface examination will be performed in accordance with ASME Section III on the area to be welded.

(b) A liquid penetrant examination of the completed repair weld (including weld pads) shall be performed in accordance with NB-5000 of ASME Section III after the completed weld has been at ambient temperature for at least 48 hours.

(c) An ultrasonic examination of the completed repair weld (including weld pads) shall be performed in accordance with NB-5000 of ASME Section III after the completed weld has been at ambient temperature for at least 48 hours.

(d) NDE personnel performing liquid penetrant and ultrasonic examinations will be qualified and certified in accordance with NB-5500.

5.0 DOCUMENTATION

Use of Request No. W3-R&R-003 shall be documented on NIS-2. Alternatively, repairs may be documented on Form NIS-2A as described in Code Case N-532-1 based on appropriate NRC approval.