Entergy

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Michael A. Krupa
Director
Nuclear Safety & Licensing

CNRO-2002-00008

March 4, 2002

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

SUBJECT: Entergy Operations, Inc.
Proposed Alternative to ASME Code Requirements for Weld Repairs

Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313 and 50-368
License Nos. DPR-51 and NPF-6

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

Dear Sir or Madam:

Pursuant to 10CFR50.55a(a)(3)(i), Entergy Operations, Inc. (Entergy) proposes an alternative method to the temper bead welding requirements of ASME Section XI IWA-4500 and IWA-4300. As documented in Request No. PWR-R&R-001, Rev. 0 (see Enclosure 1), Entergy proposes to perform ambient temperature temper bead welding repairs to reactor pressure vessel (RPV) head penetration nozzles. This request applies to Arkansas Nuclear One (ANO) – Units 1 and 2, and Waterford Steam Electric Station – Unit 3 (Waterford 3).

Entergy plans to perform inspections of various RPV penetrations during the upcoming refueling outages at both ANO units and at Waterford 3. The Waterford 3 outage, the first of the three, is currently scheduled to begin in March 2002. Currently, there is no evidence of leakage; however, we are submitting this request in order to proactively prepare for possible repairs that may be required in the event cracks are discovered. Therefore, Entergy requests that the NRC Staff approve PWR-R&R-001, Rev. 0 by April 2, 2002, in order to support inspection activities at Waterford 3. ***Following NRC approval, Entergy will incorporate PWR-R&R-001, Rev. 0 into each facility's Inservice Inspection (ISI) Plan.***

A047

This request is similar to those recently submitted to the Staff by Surry Power Station Units 1 and 2[1] and Calvert Cliffs Nuclear Power Plant[2].

This letter contains one commitment as denoted above in bold, italicized text.

If you have any questions or require addition information, please contact Guy Davant of my staff at (601) 368-5756.

Sincerely,

MAK/GHD/baa

Enclosure:
1. Request No. PWR-R&R-001, Rev. 0

cc: Mr. C. G. Anderson (ANO)
Mr. W. R. Campbell (ECH)
Mr. J. K. Thayer (ECH)
Mr. J. E. Venable (W3)

Mr. T. W. Alexion, NRR Project Manager (ANO-2)
Mr. R. L. Bywater, NRC Senior Resident Inspector (ANO)
Mr. N. Kalyanam, NRR Project Manager (W3)
Mr. E. W. Merschoff, NRC Regional Administrator, Region IV
Mr. W. D. Reckley, NRR Project Manager (ANO-1)

[1] Letter # 01-637A from Virginia Electric and Power Company to the NRC, "ASME Section XI Relief Requests SR-27, 28, 32, and 33 – Alternative Repair Technique – Reactor Vessel Head," dated October 30, 2001

[2] Letter from Constellation Nuclear – Calvert Cliffs Nuclear Power Plant to the NRC, "ASME Section XI Relief Request to Use Alternative Techniques for Reactor Vessel Head Repair," dated February 7, 2002

CNRO-2002-00008

ENCLOSURE 1

REQUEST No. PWR-R&R-001, Rev. 0

ENTERGY OPERATIONS, INC.
ARKANSAS NUCLEAR ONE UNITS 1 and 2
WATERFORD 3 NUCLEAR STEAM ELECTRIC STATION
REQUEST NO. PWR-R&R-001, Revision 0

I. COMPONENT/EXAMINATION

Component/Number: 1R-1, 2R-1, and RC MRCT0001,

Description: Reactor Pressure Vessel (RPV) Head Penetration Nozzles

Code Class: 1

References:

1. ASME Section XI, 1992 Edition with portions of the 1993 Addenda as listed in References 9 , 10, and 12
2. ASME Section III, Subsection NB, 1965 Edition, Summer 1967 Addenda
3. ASME Section III, Subsection NB, 1968 Edition, Summer 1970 Addenda
4. ASME Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda
5. ASME Section III, Subsection NB, 1971 Edition, Summer 1972 Addenda
6. ASME Section III, Subsection NB, 1989 Edition
7. ASME Section XI Code Case N-638, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW Temper Bead Technique"
8. EPRI Report GC-111050, "Ambient Temperature Preheat for Machine GTAW Temper Bead Applications"
9. CEP-ISI-001, "Waterford 3 Steam Electric Station Inservice Inspection Plan"
10. CEP-ISI-004, "Arkansas Nuclear One Unit 2 Inservice Inspection Plan"
11. Letter 1CAN090102, "30 Day Response to NRC Bulletin 2001-01 for ANO-1; Circumferential Cracking of VHP Nozzles," dated September 4, 2001
12. CEP-ISI-002, "Arkansas Nuclear One Unit 1 Inservice Inspection Plan"

13. Letter 2CAN090102, "30 Day Response to NRC Bulletin 2001-01 for ANO-2; Circumferential Cracking of VHP Nozzles," dated September 4, 2001

14. Letter W3F1-2001-0081, "30 Day Response to NRC Bulletin 2001-01 for Waterford 3; Circumferential Cracking of VHP Nozzles," dated September 4, 2001

Unit / Inspection Interval:	Arkansas Nuclear One Unit 1 (ANO-1) / Third (3rd) 10-Year interval
	Arkansas Nuclear One Unit 2 (ANO-2) / Third (3rd) 10-Year interval
	Waterford 3 Steam Electric Station (Waterford 3) / Second (2nd) 10-Year Interval

II. REQUIREMENTS

Subarticle IWA-4170 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."

The original construction codes for the RPVs at ANO-1, ANO-2, and Waterford 3 are specified below. However, as allowed by ASME Section XI, repairs will be performed in accordance with the 1989 Edition of ASME Section III and the proposed alternative of this relief request.

- **ANO-1**: ASME Section III, Subsection NB, 1965 Edition, Summer 1967 Addenda.
- **ANO-2**: ASME Section III, Subsection NB, 1968 Edition, Summer 1970 Addenda.
- **Waterford 3**: ASME Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda; fracture toughness requirements comply with Summer 1972 Addenda.

ASME Section III establishes detailed requirements for performing base material and weld repairs which often include requirements to perform postweld heat treatment (PWHT). When repairs of RPV head penetration nozzles are performed, PWHT of the RPV head would be required under the following conditions:

- Weld repair of RPV head penetration nozzles where 1/8" or less of Alloy 600 base material exists between the repair cavity of the nozzle and the ferritic base material of the RPV head.

- Weld repair of RPV head penetration nozzle J-welds where 1/8" or less of Inconel weld metal exists between the J-weld repair cavity and the ferritic base material of the RPV head.

Postweld heat treatment requirements are specified in NB-4620 of ASME Section III. However, PWHT of the RPV head would be extremely difficult and could have undesirable effects. Section 2.1 of the Electric Power Research Institute (EPRI) Report GC-111050, *Ambient Temperature Preheat for Machine GTAW Applications,* (Reference 8) states, "Localized heat treatments are extremely difficult to facilitate and often can produce undesirable side effects in terms of component distortion, thermal stresses and material degradation attendant to such procedures." Under these conditions, the alternative ASME Section XI rules of IWA-4500 may be used for temper bead welding.

IWA-4500 establishes requirements for performing repair welding using temper bead welding procedures. The rules of IWA-4530 apply to dissimilar materials such as welds that join P-Number 43 nickel alloy to P-Number 3 low alloy steels using F-Number 43 Inconel filler metal. When repairing RPV head penetration nozzle J-welds and base materials and the repair cavity is within 1/8" of the ferritic base materials of the RPV head, then the temper bead rules of IWA-4530 apply. If the Gas Tungsten Arc Welding (GTAW) process is used, 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 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 post weld soak or hydrogen bake-out at 450°F - 550°F for a minimum of 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

RPV penetration nozzles at ANO-2 and Waterford 3 are considered to have a moderate susceptibility to Primary Water Stress Corrosion Cracking (PWSCC) based upon a susceptibility ranking of greater than 5 effective full power years (EFPY) but less than 30 EFPY from the Oconee Nuclear Station 3 time-at-temperature condition. ANO-1 has already experienced cracking. Susceptibility rankings for ANO-1, ANO-2, and Waterford 3 have been reported to the NRC in response to NRC Bulletin 2001-01 (References 11, 13, and 14).

Should repair welding of RPV head penetration nozzle J-welds or base materials encroach (within 1/8") on the ferritic base material of the RPV head, temper bead weld repairs would be required.

B. Proposed Alternative

Pursuant to 10CFR50.55a(a)(3)(i), Entergy proposes an alternative to the temper bead welding requirements of IWA-4500 and IWA-4530. 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." This request for alternative is specific to the repairs described below.

- Weld repair of RPV head penetration nozzle J-welds where 1/8" or less of Inconel weld metal exists between the J-weld repair cavity and the ferritic base material of the RPV head.
- Weld repair of RPV head penetration nozzles where 1/8" or less of Alloy 600 base material exists between the repair cavity of the nozzle and the ferritic base material of the RPV head.

IV. BASIS FOR PROPOSED ALTERNATIVE

IWA-4500 and IWA-4530 of ASME Section XI establish requirements for performing temper bead welding of "dissimilar materials". Based upon these requirements, 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 or hydrogen bake-out at 450°F - 550°F for a minimum of 4 hours is also required.

The IWA-4500 temper bead welding process is a time and dose intensive process. Resistant heating blankets are attached to the RPV head; typically a capacitor discharge stud welding process is used. Because preheat, interpass, and postweld soak temperatures must be monitored, thermocouples must also be attached to the RPV head using a capacitor discharge welding process. Prior to heat-up, 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 RPV head. Thermocouples and stud welds are removed by grinding. After removal, the removal areas are 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. Because the ASME Code does not presently include rules for ambient temperature temper bead welding, Entergy proposes the alternative in Section III above.

Suitability of Ambient Temperature Temper Bead

Research by EPRI and other organizations on the use of an ambient temperature welding 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 affects of the ambient temperature temper bead welding process (as discussed in Attachment 1) on mechanical properties of repair welds, hydrogen cracking, and restraint cracking are addressed below.

1. MECHANICAL PROPERTIES

The principle 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, "the 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 to 550°F for 4 hours (P-Number 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 to 550°F, the postweld soak does not stress relieve, temper, or alter the mechanical properties of the weldment in any manner.

The proposed ambient temperature temper bead welding procedure will be qualified prior to repair welding in accordance with Section 2.1 of Attachment 1.

Simulating base materials, filler metals, restraint, impact properties, and 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. It should also be noted that the qualification requirements of Section 2.1 of Attachment 1 are very similar to those in IWA-4500.

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 manifest 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 was also established to bake-out or facilitate diffusion of any remaining hydrogen from the weldment. However, while hydrogen cracking is a concern for Shielded Metal Arc Welding (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 are susceptible to moisture absorption from the environment. Conversely, the GTAW process utilizes dry inert shielding gases that covers 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 which 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.

As explained above, the potential for hydrogen induced cracking is greatly reduced by using machine GTAW process. However, should it occur, cracks would be detected by the final nondestructive examinations (NDE) performed after the completed repair weld has been at ambient temperature for at least 48 hours as required by paragraph 4(b) of Attachment 1. Regarding this issue, EPRI Report GC-111050, Section 6.0 concluded the following:

"No preheat temperature or postweld bake above ambient temperature is required to achieve sound machine GTAW temper bead repairs that have high toughness and ductility. This conclusion is based on the fact that the GTAW process is an inherently low hydrogen process regardless of the welding environment. Insufficient hydrogen is available to be entrapped in solidifying weld material to support hydrogen delayed cracking. Therefore, no preheat nor postweld bake steps are necessary to remove hydrogen because the hydrogen is not present with the machine GTAW process."

3. COLD RESTRAINT CRACKING

Cold 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. Additionally, even if cold cracking were to occur, it would be detected by the final NDE which is performed after the completed repair weld has been at ambient temperature for at least 48 hours as required by paragraph 4(b) of Attachment 1.

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 affect 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. EPRI Report GC-111050, Section 6.0 concluded the following:

"Repair of RPV components utilizing machine GTAW temper bead welding at ambient temperature produces mechanical properties that are commonly superior to those of the service-exposed substrate. The risk of hydrogen delayed cracking is minimal using the GTAW process. Cold stress cracking is resisted by the excellent toughness and ductility developed in the weld HAZ (heat affected zone). Process design and geometry largely control restraint considerations, and these factors are demonstrated during weld procedure qualification."

V. CONCLUSION

10CFR50.55a(a)(3)(i) 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 Reference 1 and as described in Section II of this request would result in unwarranted radiological exposure. The proposed alternative would provide an acceptable level of quality and safety. The proposed alternative would also result in a reduction of radiological exposure to personnel. Therefore, we request that the proposed alternative be authorized pursuant to 10CFR50.55a(a)(3)(i).

RELIEF REQUEST NO. PWR-R&R-001

ATTACHMENT 1

DISSIMILAR METAL WELDING USING AMBIENT TEMPERATURE MACHINE GTAW TEMPER BEAD TECHNIQUE

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" 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) Peening may be used, except on the initial and final layers.

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.

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

(e) The maximum interpass temperature for the first three layers of the test assembly will be 150°F. For the balance of the welding, the maximum interpass temperature shall be 350°F.

(f) 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.

(g) 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 (i) below, but shall be in the base metal.

(h) Charpy V-notch tests of the ferritic weld metal of the procedure qualification shall meet the requirements as determined in subparagraph (g) above.

(i) 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 (g) 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.

(j) 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.

(b) Dissimilar metal welds shall be made using A-No. 8 weld metal (QW-442) for P-No. 8 to P-No. 1, 3, or 12(A, B or C) weld joints or F-No. 43 weld metal (QW-432) for P-No. 8 or 43 to P-No. 1, 3, or 12(A, B or C) 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 overlay 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 ferritic material to ensure that the HAZ and ferritic weld metal are tempered. Subsequent layers will be deposited with a heat input not exceeding that used for layers beyond the third layer in the procedure qualification. For similar-metal welding, the completed weld shall have at least one layer of weld reinforcement deposited. This reinforcement shall be removed by mechanical means, so that the finished surface is essentially flush with the surface surrounding the weld.

(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 on the area to be welded.

(b) The final weld surface and the band around the area defined in Paragraph 1.0 (d) shall be examined using surface and ultrasonic methods when the completed weld has been at ambient temperature for a least 48 hours. For partial penetration welds the repair weld shall be progressively examined in accordance with NB-5245 of ASME Section III.

(c) Areas from which weld-attached thermocouples have been removed shall be ground and examined using a surface examination method.

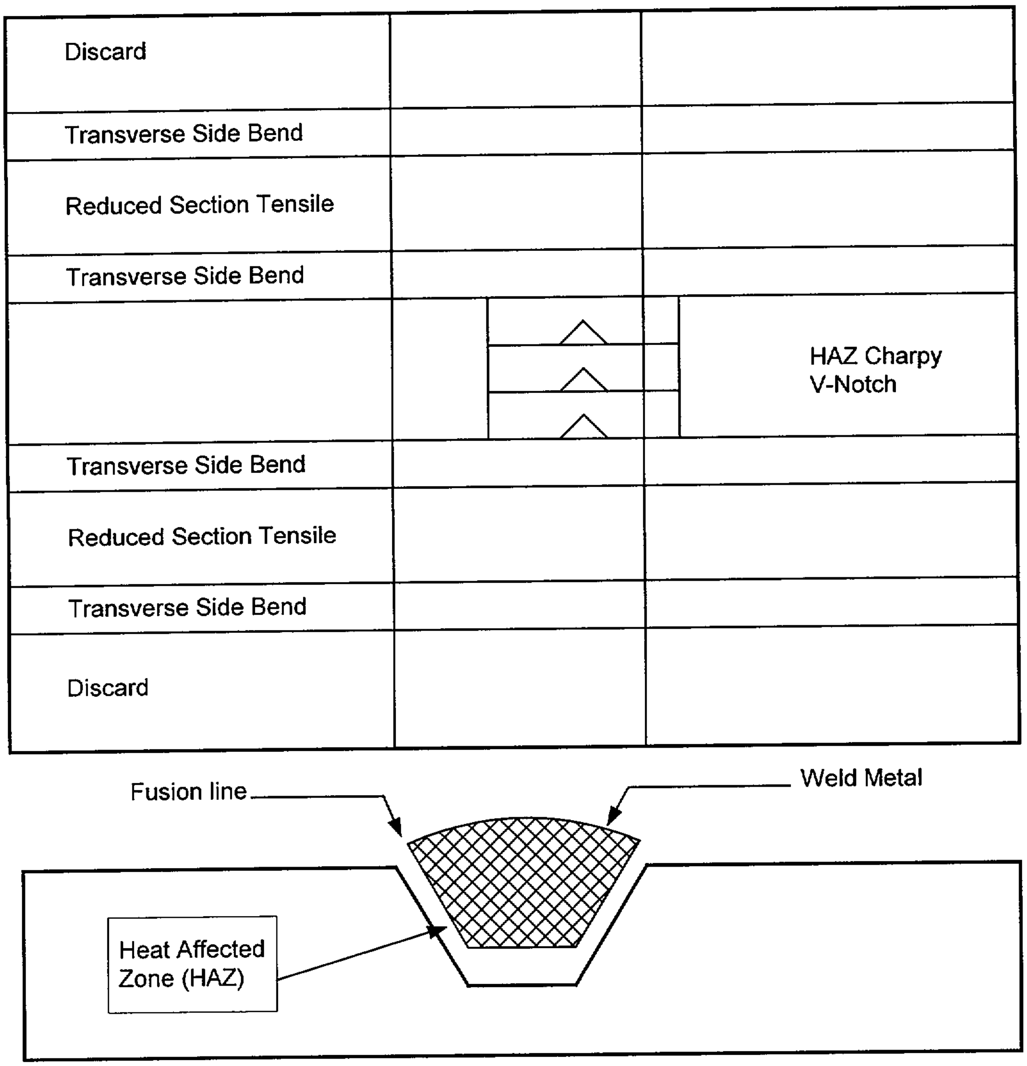
(d) Nondestructive Examination (NDE) personnel will be qualified in accordance with IWA-2300 or NB-5500.

(e) Surface examination acceptance criteria shall be in accordance with NB-5340 or NB-5350, as applicable. Additional acceptance criteria may be specified by the Owner to account for differences in weld configuration.

5.0 DOCUMENTATION

Use of Request No. PWR-R&R-001, Rev. 0 shall be documented on NIS-2. Alternatively, repairs may be documented on Form NIS-2A as described in Code Case N-532 if prior approval is obtained from the NRC.

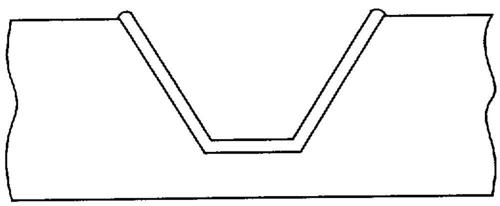
DISSIMILAR METAL WELDING USING AMBIENT TEMPERATURE MACHINE GTAW TEMPER BEAD TECHNIQUE



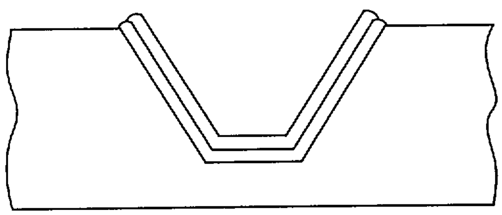
GENERAL NOTE: Base Metal Charpy impact specimens are not shown.

Figure 1 - QUALIFICATION TEST PLATE

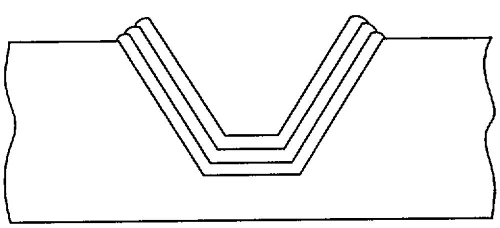
DISSIMILAR METAL WELDING USING AMBIENT TEMPERATURE MACHINE GTAW TEMPER BEAD TECHNIQUE



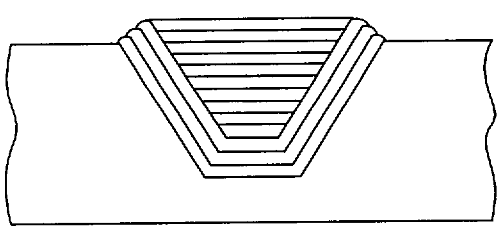
Step 1: Deposit layer one with first layer weld parameters used in qualification.



Step 2: Deposit layer two with second layer weld parameters used in qualification. NOTE: Particular care shall be taken in application of the second layer at the weld toe to ensure that the weld metal and HAZ of the base metal are tempered.



Step 3: Deposit layer three with third layer weld parameters used in qualification. NOTE: Particular care shall be taken in application of the third layer at the weld toe to ensure that the weld metal and HAZ of the base metal are tempered.



Step 4: Subsequent layers to be deposited as qualified, with heat input less than or equal to that qualified in the test assembly. NOTE: Particular care shall be taken in application of the fill layers to preserve the temper of the weld metal and HAZ.

GENERAL NOTE: The illustration above is for similar-metal welding using a ferritic filler material. For dissimilar-metal welding, only the ferritic base metal is required to be welded using steps 1 through 3 of the temperbead welding technique.

Figure 2 - AUTOMATIC OR MACHINE GTAW TEMPER BEAD WELDING