Entergy

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CNRO-2002-00020

April 2, 2002

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

SUBJECT: Entergy Operations, Inc.
Proposed Alternative to ASME Examination Requirements for Repairs Performed on Reactor Vessel Head Penetrations

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

REFERENCE: Letter CNRO-2002-00006 from Entergy Operations, Inc. to the NRC, "Proposed Alternative to ASME Examination Requirements for Repairs Performed on Reactor Vessel Head Penetrations," dated February 28, 2002

Dear Sir or Madam:

In the referenced letter, Entergy Operations, Inc. (Entergy) submitted Relief Request W3-R&R-001, Rev. 0, which requested relief from performing examinations of base material weld repairs made to reactor pressure vessel (RPV) nozzles as required by ASME Code Section XI IWA-4331(a) and Section III NB-2539.4. This request is applicable to the Waterford Steam Electric Station, Unit 3 (Waterford 3).

In a recent telephone conference call, NRC staff representatives requested additional information to support review of the relief request. In response to the NRC's request, Entergy is submitting revised request W3-R&R-001, Rev. 0, which contains the requested information. This revised request, contained in Enclosure 1, replaces the previously submitted request in its entirety. Revision bars in the margins of the request denote changes.

Based on results of completed inspections performed during the current refueling outage at Waterford 3, Entergy will not require this request to support outage repair activities as expressed in the referenced letter. Therefore, Entergy revises the need date for PWR-R&R-001 to December 2, 2002. Entergy wishes to express our gratitude to the staff for its willingness to provide the resources necessary to meet our original need date.

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This letter contains no new commitments.

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

Sincerely,

MAK/GHD/baa

Enclosure:
1. Request No. W3-R&R-001

cc: Mr. W. R. Campbell (ECH)
Mr. J. K. Thayer (ECH)
Mr. J. E. Venable (W3)
Mr. G. A. Williams (ECH)

Mr. T. R. Farnholtz, NRC Senior Resident Inspector (Waterford 3)
Mr. N. Kalyanam, NRR Project Manager (Waterford 3)
Mr. E. W. Merschoff, NRC Regional Administrator, Region IV

CNRO-2002-00020

ENCLOSURE 1

REQUEST No. W3-R&R-001, Rev. 0

ENTERGY OPERATIONS, INC.
WATERFORD STEAM ELECTRIC STATION, UNIT 3
2ND TEN YEAR INTERVAL
REQUEST NO. W3-R&R-001

I. COMPONENT/EXAMINATION

Component/Number: 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 Reference 6
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 III, Subsection NB, 1992 Edition, 1993 Addenda
6. CEP-ISI-001, Waterford 3 Steam Electric Station Inservice Inspection Plan
7. Letter W3F1-2001-0081, "30 Day Response to NRC Bulletin 2001-01 for Waterford 3; Circumferential Cracking of VHP Nozzles," dated September 4, 2001
8. American Society of Non-Destructive Testing document SNT-TC-1A, "Personnel Qualification and Certification in Non-Destructive Testing," 1984 Edition
9. Letter CNRO-2002-00013, "Use of Electrical Discharge Machining"

Unit: Waterford Steam Electric Station, Unit 3 (Waterford 3)

Inspection Interval: Second (2^{nd}) 10-Year Interval

II. 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."

The original construction code for the Waterford 3 RPV is ASME Section III, Subsection NB, 1971 Edition, Summer 1971 Addenda. Fracture toughness requirements comply with the Summer 1972 Addenda. As allowed by ASME Section XI, localized weld repairs of the RPV penetration nozzle base materials will be performed in accordance with the 1989 Edition of ASME Section III. The applicable ASME Section III requirements are discussed below.

- NB-4000

  NB-4000 establishes fabrication, installation, and repair requirements for ASME Class 1 components. According to NB-4131, when defects are identified in materials that exceed the limits of NB-2500, then the condition is corrected in accordance with the requirements of NB-2500 for the applicable product form, with the exception that the limitation on depth of weld repair does not apply. As shown in Section III of this relief request, the Waterford 3 RPV penetration nozzles are manufactured from SB-166 round bar and SB-167 pipe/tube. Based on the ASME Code, the repair requirements of NB-2550 apply to all of the RPV penetration nozzles.

- NB-2559

  NB-2550 establishes examination and repair requirements that are applicable to ASME Class 1 tubular products such as RPV penetration nozzles. NB-2559 establishes requirements for performing localized repairs by welding. NB-2559 states, "Repair of defects shall be in accordance with NB-2539, except repair by welding is not permitted on copper-nickel alloy or nickel alloy materials." Based on this requirement, localized repair welding of the RPV penetration nozzle base materials is performed in accordance with NB-2539.

  NB-2559 also includes a restriction that prohibits repair welding on copper-nickel alloy or nickel alloy materials. Although not specifically stated, this restriction was only intended to apply to heat exchanger tubing; it was not intended to restrict welding repairs of other copper-nickel or nickel alloy materials such as nozzles. The ASME Code corrected this requirement in the 1993 Addenda of the 1992 Edition as follows: "Repair of defects shall be in accordance with NB-2539, except repair by welding is not permitted on copper-nickel alloy or nickel alloy *heat exchanger tubes*." Therefore, repair welding of RPV penetration nozzles base material can be performed in accordance with NB-2539 as clarified by the 1993 Addenda of ASME Section III.

- NB-2539

  NB-2539 establishes requirements for performing repairs by welding. These requirements address defect removal, qualification of welding procedures and welders, blending of repaired areas, and examination of repair welds. As invoked by NB-2559, these requirements apply to localized weld repairs of RPV penetration nozzles. Examination requirements for completed repair welds are specified in NB-2539.4 as follows: "Each repair weld shall be examined by the magnetic particle or liquid penetrant method. In addition, when the depth of the repair cavity exceeds the lesser of 3/8" or 10% of the section thickness, the repair weld shall be

radiographed after repair in accordance with NB-5110 and to the acceptance standards of NB-5320."

ASME Section XI also imposes repair requirements that supplement or amend the repair rules of the construction code. Where applicable, compliance with these additional requirements is mandatory. With respect to localized repair welding of RPV penetration nozzle base materials, the following supplemental requirements apply:

- IWA-4310

  IWA-4310 establishes requirements for performing defect removal. These requirements also permit the acceptance of unremoved portions of flaws based upon the flaw evaluation rules of ASME Section XI. Supplementing the defect removal requirements in ASME Section III, the requirements of IWA-4310 apply to the performance of localized weld repairs of RPV penetration nozzle base materials.

  IWA-4310 states: "Defects shall be removed or reduced in size in accordance with this paragraph. The component shall be acceptable for continued service if the resultant section thickness created by the cavity is equal to or greater than the minimum design thickness. If the resulting section thickness is reduced below the minimum design thickness, the component shall be repaired or replaced in accordance with this Article. Alternatively, the defect removal area and any remaining portion of the flaw may be evaluated and the component accepted in accordance with appropriate flaw evaluation rules of Section XI or the design rules of either the construction code, or Section III, when the Construction Code was not Section III."

- IWA-4331(a)

  IWA-4331(a) establishes nondestructive examination requirements that are applicable to defect removal surfaces including surfaces of repair cavities prepared for welding. Supplementing the examination requirements in ASME Section III, IWA-4331(a) applies to localized weld repairs in RPV penetration nozzle base materials.

  IWA-4331(a) states: "After final grinding, the affected surfaces, including surfaces of cavities prepared for welding, shall be examined by the magnetic particle or liquid penetrant method to ensure that the indication is reduced to an acceptable limit in accordance with IWA-3000. This examination is not required when defect elimination removes the full thickness of the weld and the back side of the weld joint is not accessible for removal of examination materials."

III. PROPOSED ALTERNATIVES

A. Background

The Waterford 3 RPV head has 102 penetrations that include 91 control element drive mechanism (CEDM) nozzles, 10 incore instrument (ICI) nozzles, and 1 vent line nozzle. Details of the nozzles are provided in Figures 1 and 2. The materials and dimensions of the RPV penetration nozzles are summarized below.

RPV Penetration Nozzle	Material	Dimensions		
		Outside Dia.	Inside Dia.	Thickness
CEDM	SB-166, N06600	4.050"	2.728"	0.6610"
ICI	SB-167, N06600	5.563"	4.750"	0.4065"
Vent Line	SB-167, N06600	1.050"	0.742"	0.1540"

These nozzles 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 – Unit 3 time-at-temperature condition. The Waterford 3 susceptibility ranking was reported to the NRC in Waterford 3's response to NRC Bulletin 2001-01 (Reference 7).

Waterford 3 is performing inspections of RPV penetration nozzles as described in Waterford 3's response to NRC Bulletin 2001-01 (Reference 7). Based on these inspection results, the following repairs may be required.

- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, above the J-weld. See Figures 2 and 3.
- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, adjacent to the J-weld. See Figures 2 and 4.
- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, below the J-weld. See Figures 2 and 5.
- Localized weld repairs of RPV penetration nozzle base materials along the outside diameter of the nozzle below the J-weld. See Figures 2 and 6.

This relief request addresses *nondestructive examinations* associated with the above repairs. However, it does not apply when a temper bead welding process is utilized to perform weld repairs of RPV penetration nozzle base materials. Additionally, this relief request does not apply to weld repairs of RPV penetration nozzle J-welds.

In the event inspection results require repair welding of RPV penetration nozzle base materials, the requirements of the Construction Code and ASME Section XI, as described in Section II above, provide an impracticality for which relief is requested. To further clarify these requirements, an overview of the proposed base material repair scenario is provided below. This overview identifies the various examination sequences required by the Construction Code and ASME Section XI.

Localized Weld Repair of RPV penetration nozzle Base Materials

1. **Defect Removal**: Defects are either removed or reduced in size in accordance with IWA-4310. The IWA-4310 defect removal requirements are consistent with NB-2539.1 in that both of these paragraphs require that the defect be removed or reduced to an imperfection of acceptable size.

However, IWA-4310 also includes a provision that allows acceptance of a defect removal area and an unremoved portion of a flaw based on an evaluation performed "in accordance with the appropriate flaw evaluation rules of ASME Section XI". The applicable paragraphs of ASME Sections III and XI are provided below.

- ASME Section III, NB-2539.1 states in part: "The defect shall be removed or reduced to an imperfection of acceptable size..."

- ASME Section XI, IWA-4310 states: "Defects shall be removed or reduced in size in accordance with this paragraph. The component shall be acceptable for continued service if the resultant section thickness created by the cavity is equal to or greater than the minimum design thickness. If the resulting section thickness is reduced below the minimum design thickness, the component shall be repaired or replaced in accordance with this Article. Alternatively, the defect removal area and any remaining portion of the flaw may be evaluated and the component accepted in accordance with appropriate flaw evaluation rules of Section XI or the design rules of either the construction code, or Section III, when the Construction Code was not Section III."

2. **Defect Removal Methods**: When defects are removed using a thermal removal process, a minimum of 1/16" of material must be mechanically removed from the thermally processed areas in accordance with IWA-4322. The ASME Section XI requirement pertaining to defect removal supplements the defect removal requirements of ASME Section III. While both ASME Sections III and XI allow use of thermal and mechanical removal processes, only ASME Section XI requires the mechanical removal of 1/16" (minimum) of material from all thermally processed areas. The applicable paragraphs of ASME Sections III and XI are provided below.

   - ASME Section III, NB-2539.1 states in part: "The defect shall be removed or reduced to an imperfection of acceptable size by suitable mechanical or thermal cutting or gouging methods..."

   - ASME Section XI, IWA-4322 states: "If thermal removal processes are used on P-No. 8 and P-No. 43 materials, a minimum of 1/16" material shall be mechanically removed from the thermally processed areas."

   - ASME Section XI, IWA-4330 allows the use of mechanical removal processes on defect removal areas in repair weld cavities.

   As an alternative to IWA-4322 (separate from this request), Entergy plans to use the electrical discharge machining (EDM) process to perform defect removal based on NRC approval of Relief Request PWR-R&R-002, Revision 0 (Reference 9).

3. **Preparation of Repair Cavity**: Repair cavities for localized weld repairs of RPV penetration nozzle base materials are prepared in accordance with IWA-4330. The ASME Section XI requirements in IWA-4330 supplement the repair cavity preparation requirements of ASME Section III. Although

NB-2539.1 of ASME Section III states that the repair cavity is to be prepared for welding, it does not establish requirements to accomplish this. IWA-4330(b) does. According to IWA-4330(b), the repair cavity must be ground smooth and clean with beveled sides and edges rounded to provide suitable accessibility for welding. The applicable paragraphs of ASME Sections III and XI are provided below.

- ASME Section III, NB-2539.1 states in part: "The defect shall be removed or reduced to an imperfection of acceptable size ... and the cavity prepared for welding."

- ASME Section XI, IWA-4330(b) states: "Where repair welding is required, the cavity shall be ground smooth and clean with beveled sides and edges rounded to provide suitable accessibility for welding."

4. **Repair Cavity Examination:** Prior to welding, the repair cavity is examined by the liquid penetrant method in accordance with IWA-4331(a). Although NB-2558(b) of ASME Section III specifies that the repair cavity is to be examined by the examination method that originally disclosed the defect, IWA-4331(a) of ASME Section XI amends this requirement by requiring a liquid penetrant examination regardless of product form. [Note that NB-2539, as invoked by NB-2559, does not address examination of the repair cavity. Repair cavity examinations are performed in accordance with NB-2558(b)]. The applicable paragraphs of ASME Sections III and XI are provided below.

   - ASME Section III, NB-2558(b) states: "After defect elimination, the area is examined by the method which originally disclosed the defect to assure that the defect has been removed or reduced to an imperfection of acceptable size."

   - ASME Section XI, IWA-4331(a) states: "After final grinding, the affected surfaces, including surfaces of cavities prepared for welding, shall be examined by the magnetic particle or liquid penetrant method to ensure that the indication is reduced to an acceptable limit in accordance with IWA-3000. This examination is not required when defect elimination removes the full thickness of the weld and the back side of the weld joint is not accessible for removal of examination materials."

     An alternative to the repair cavity examination requirements of IWA-4331(a) is proposed in Section III.B.

5. **Qualification of Welding Procedures and Welders:** Welding procedures and welders or welding operators are qualified in accordance with NB-4000 of ASME Section III and ASME Section IX as required by NB-2539.2. ASME Section XI invokes the qualification requirements of ASME Section III without specifying any supplements or amendments. The applicable paragraphs of ASME Sections III and XI are provided below.

   - ASME Section III, NB-2539.2 states: "The welding procedures and welders or welding operators shall be qualified in accordance with NB-4000 and Section IX."

- ASME Section XI, IWA-4170(b) 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."

6. **Blending of Repaired Areas:** The weld surface is blended uniformly into the surrounding surface after completing the repair as required by NB-2539.3. ASME Section XI invokes the repair requirements of ASME Section III without specifying any supplements or amendments. The applicable paragraphs of ASME Sections III and XI are provided below.

   - ASME Section III, NB-2539.3 states: "After repair, the surface shall be blended uniformly into the surrounding surface."

   - ASME Section XI, IWA-4170(b) 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."

7. **Examination of Repair Welds**: Repair welds in RPV penetration nozzles are examined by the liquid penetrant method in accordance with NB-2539.4. When the repair cavity depth exceeds the lesser of 3/8" or 10% of the section thickness, a radiographic examination of the repair weld is also required by NB-2539.4. ASME Section XI invokes the ASME Section III examination requirements without specifying any supplements or amendments. The applicable paragraphs of ASME Sections III and XI are provided below.

   - ASME Section III, NB-2539.4 states: "Each repair weld shall be examined by the magnetic particle or liquid penetrant method. In addition, when the depth of the repair cavity exceeds the lesser of 3/8" or 10% of the section thickness, the repair weld shall be radiographed after repair in accordance with NB-5110 and to the acceptance standards of NB-5320."

   - ASME Section XI, IWA-4170(b) 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."

   Alternatives to the examination requirements of NB-2539.4 are proposed in Section III.B.

B. Proposed Alternatives

Pursuant to the provisions of 10CFR50.55a(g)(5)(iii), Entergy requests relief from the following examination requirements applicable to localized repair welds in RPV penetration nozzle base materials:

1. The ASME Section XI, IWA-4331(a) magnetic particle or liquid penetrant examination of repair cavities.

2. The ASME Section III, NB-2539.4 magnetic particle or liquid penetrant examination of completed repair welds.

3. The ASME Section III, NB-2539.4 radiographic examination of completed repair welds when the depth of the repair cavity exceeds the lesser of 3/8" or 10% of the section thickness.

As an alternative to the above examinations, Entergy proposes the following:

1. As an alternative to a magnetic particle or liquid penetrant examination of the repair cavity in accordance with IWA-4331(a) of ASME Section XI, Entergy proposes to perform the following:

   a) **Flaw Characterization:** Prior to defect removal, RPV penetration nozzles will be examined by the ultrasonic and eddy current examination methods to characterize all flaws.

   b) **Flaw Evaluation**: All flaws in RPV nozzles will be evaluated for acceptance. Flaws that exceed the acceptance limits of the flaw evaluation will be reduced to an acceptable size prior to welding.

   c) **Examination of Repair Weld**: Upon completion of welding, the repair weld will be examined by the ultrasonic and eddy current methods to verify that the as-left dimensions of the flaw comply with the acceptance limits. When the eddy current examination cannot be performed due to the surface profile of the repair weld or other prohibitive conditions, then a liquid penetrant examination will be performed as an alternative.

      - Ultrasonic examinations will be performed in accordance with NB-5000 of ASME Section III. Acceptance criteria shall be in accordance with NB-5330.

      - Eddy current examinations will be performed as described in Section IV.A.

      - The liquid penetrant examination and acceptance criteria will be in accordance wit NB-2546 of ASME Section III.

2. As an alternative to a magnetic particle or liquid penetrant examination of the completed repair weld in accordance with NB-2539.4 of ASME Section III, Entergy proposes to perform an eddy current examination. When an eddy current examination cannot be performed due to the surface profile of the repair weld or other prohibitive conditions, then a liquid penetrant examination will be performed.

   - Eddy current examinations will be performed as described in Section IV.B.

   - The liquid penetrant examination and acceptance criteria will be in accordance wit NB-2546 of ASME Section III.

3. As an alternative to the radiographic examination of the completed repair weld in accordance with NB-2539.4 of ASME Section III when the depth of the repair cavity exceeds the lesser of 3/8" or 10% of the section thickness, Entergy proposes to perform ultrasonic and eddy current examinations.

   - Ultrasonic examinations will be performed in accordance with NB-5000 of ASME Section III. Acceptance criteria shall be in accordance with NB-5330.

   - Eddy current examinations will be performed as described in Section IV.C.

The alternatives proposed in this relief request are specific to the repairs described below.

- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, above the J-weld. See Figures 2 and 3.

- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, adjacent to the J-weld. See Figures 2 and 4.

- Localized weld repairs of RPV penetration nozzle base materials along the inside diameter of the nozzle, below the J-weld. See Figures 2 and 5.

- Localized weld repairs of RPV penetration nozzle base materials along the outside diameter of the nozzle below the J-weld. See Figures 2 and 6.

IV. BASIS FOR DETERMINING IMPRACTICALITY AND SUITABILITY OF PROPOSED ALTERNATIVES

A. IWA-4331(a) – Surface Examination of Repair Cavity

IWA-4331(a) of ASME Section XI requires a magnetic particle or liquid penetrant examination of all repair cavities prior to repair welding. However, where a portion of the flaw is left in the repair cavity of the RPV penetration nozzle, a liquid penetrant examination of the repair cavity cannot be performed.

Impracticality of Repair Cavity Surface Examinations

Magnetic particle testing is a nondestructive method used to detect surface and near-surface discontinuities in magnetic materials. The basic principle of magnetic particle inspection is that when a ferromagnetic material contains one or more discontinuities in the path of the magnetic flux, minute poles are set up at the discontinuities. These poles have a stronger attraction for the magnetic particles than the surrounding surface of the material. However, the Waterford 3 RPV penetration nozzles are manufactured from SB-166 and SB-167 nickel alloys, which are not magnetic. Therefore, examination of repair weld cavities in RPV penetration nozzles by the magnetic particle method is not possible.

Liquid penetrant testing is a nondestructive method that reveals open-surface discontinuities by bleed-out of a liquid penetrant medium against a contrasting background developer. The technique is based on the ability of a penetrating liquid to wet the surface opening or crevice of a discontinuity and to be drawn into

the discontinuity by capillary action. If the discontinuity is significant, penetrant will be held in the cavity when the excess is removed from the surface. Upon application of a developer, blotter action draws the penetrant from the discontinuity to provide a contrasting indication on the surface. When a surface examination of an RPV penetration nozzle is required, liquid penetrant would be the appropriate examination method.

A liquid penetrant examination of repair cavity surfaces is allowed by IWA-4331(a) as an alternative to magnetic particle examination. However, the repair cavity surfaces must also exhibit a high state of cleanliness prior to welding. According to NB-4412, "The surfaces for welding shall be free of scale, rust, oil, grease, and other deleterious material. The surfaces for welding shall be protected from deleterious contamination and from rain, snow, and wind during welding. Welding shall not be performed on wet surfaces." When a portion of a flaw is left in the repair cavity, liquid penetrant examination materials could become trapped in the as-left flaw. Trapped examination materials would be consumed during the welding process. As contaminants, the examination materials could cause cracks and other unacceptable weld defects.

ASME Section XI recognizes the deleterious affects of examination materials to a weld. According to IWA-4331(a), "This examination is not required when defect elimination removes the full thickness of the weld and backside of the weld joint is not accessible for removal of examination materials." This exemption also exists in NB-4453.1 of ASME Section III. While ASME Section XI fundamentally recognizes the deleterious affect of examination materials on a weld, it does not specifically include the as-left flaw condition in its exemption. Nonetheless, the affect of trapped examination materials on a repair weld are the same regardless of whether the examination materials are trapped in the weld root or an as-left flaw.

Suitability of Proposed Alternative

RPV penetration nozzles will be examined by the ultrasonic and eddy current examination methods as described below to characterize all flaws prior to defect excavation. Identified flaws will be evaluated for acceptance in accordance with IWB-3600. Flaws that exceed the acceptance limits of the IWB-3600 flaw evaluation will be removed or reduced to an acceptable size prior to welding. Upon completion of repair welding, the repair weld region will be re-examined using the ultrasonic and eddy current examination methods to verify that the as-left flaw dimensions are still within the acceptance limits of the IWB-3600 flaw evaluation. In the unlikely event that an eddy current examination cannot be performed due to the surface profile of a repair weld or some other prohibitive condition, then a liquid penetrant examination will be performed as an alternative. In conclusion, a surface examination is performed on a repair cavity to ensure that cracks and other unacceptable defects have been removed prior to welding. However, when a flaw is left in the component by design in accordance with IWA-4310, then a surface examination of the repair cavity is no longer beneficial. Conversely, the proposed alternative ensures that the structural integrity of the RPV penetration nozzle is maintained.

The ultrasonic examination will be performed using a combination of Time of Flight Diffraction (TOFD) and standard 0° pulse-echo techniques. The TOFD approach utilizes two pairs of 0.250" diameter, 55° refracted-longitudinal wave transducers pointed at each other. One of the transducers sends sound into the inspection volume, and the other transducer receives the reflected and diffracted signals, as they interact with the material. There will be one TOFD pair looking in the axial direction of the penetration tube, and one TOFD pair will be looking in the circumferential direction of the penetration tube. The TOFD technique is primarily responsible for detecting and characterizing planer-type defects within the full volume of the penetration tube. This TOFD ultrasonic technique will be used in the pre-inspections of the RPV penetration nozzles as well as in the post-repair inspections.

The standard 0° pulse-echo ultrasonic approach utilizes two 0.250" diameter straight beam transducers. One transducer uses a center frequency of 2.25 MHz while the other uses a frequency of 5.0 MHz. The 0° technique is primarily responsible for plotting the penetration tube outside diameter location and the J-groove attachment weld location, which will aid in defect orientation and sizing information. Additionally, the 0° technique will be capable of locating and sizing any laminar-type defects that may be encountered. These transducers will interrogate the weld repair area for lack of fusion and other laminar-type defects. This ultrasonic technique will be used in the pre-inspections of the RPV penetration nozzles as well as in the post-repair inspections.

The eddy current examination complements the ultrasonic examination by providing sensitivity to surface and subsurface flaws along the inspection surface. The eddy current approach utilizes a 5-mm diameter, "cross wound" probe design, which is capable of operating frequencies between 75 and 500 kHz. This technique is primarily responsible for detection and length sizing of defects, which are open to the inside diameter surface of the penetration tube. Since this particular probe design produces eddy currents that penetrate to approximately 0.030" into the inside diameter surface, it will also aid in the evaluation of very shallow surface defects. For post-repair inspection purposes, this eddy current examination technique will provide the necessary surface examination of the weld repair area. This eddy current technique will be used in the pre-inspections of the RPV penetration nozzles as well as in the post-repair inspections.

The above ultrasonic and eddy current examination techniques have been demonstrated capable of detecting axial and circumferential PWSCC indications in the nozzle material, utilizing cracked nozzle samples which were taken from the Oconee-3 cracked RPV penetration nozzles. Additionally, a mock-up of a typical RPV penetration nozzle was built by the EPRI Center on behalf of Entergy and the EPRI Materials Reliability Program (MRP). The mock-up was built to aid in the development of these NDE processes. This mock-up contains axial and circumferential crack-like defects in the volume of the tube, both above and below the J-groove attachment weld. Mock-up defects were fabricated by cutting narrow notches of specified lengths and depths using electrical discharge machining (EDM). The notches were then squeezed using the Cold Isostatic Process (CIP). This process produces flaws that exhibit characteristics similar to PWSCC. (The CIP process has also been used by the Performance Demonstration Initiative Program.) The described demonstrations have been performed and documented

by the MRP and EPRI. The proposed ultrasonic and eddy current examinations meet or exceed the requirements of NB-5000 of ASME Section III.

B. NB-2539.4 – Surface Examination of Repair Welds

NB-2539.4 of ASME Section III requires a magnetic particle or liquid penetrant examination of all repair welds. However, a magnetic particle examination of repair welds in RPV penetration nozzles cannot be performed.

Impracticality of Magnetic Particle Examinations of Repair Welds

Magnetic particle testing is a nondestructive method used to detect surface and near-surface discontinuities in magnetic materials. The basic principle of magnetic particle inspection is that when a ferromagnetic material contains one or more discontinuities in the path of the magnetic flux, minute poles are set up at the discontinuities. These poles have a stronger attraction for the magnetic particles than the surrounding surface of the material. However, the Waterford 3 RPV penetration nozzles are manufactured from SB-166 and SB-167 nickel alloys, which are not magnetic. Repair welds will be performed using Inconel filler metals that are also non-magnetic. Therefore, examination of repair welds in RPV penetration nozzles by the magnetic particle method is not possible.

Suitability of Proposed Alternative

Eddy current examinations have been proposed as an alternative to magnetic particle testing. The eddy current examination provide sensitivity to surface and subsurface flaws along the inspection surface. More details on the eddy current examination method is provided in Section IV.A, above.

A liquid penetrant examination of repair welds in RPV penetration nozzle base materials is an acceptable examination according to NB-2539.4. Liquid penetrant testing is a nondestructive method that reveals open-surface discontinuities by bleed-out of a liquid penetrant medium against a contrasting background developer. The technique is based on the ability of a penetrating liquid to wet the surface opening or crevice of a discontinuity and to be drawn into the discontinuity by capillary action. If the discontinuity is significant, penetrant will be held in the cavity when the excess is removed from the surface. Upon application of a developer, blotter action draws the penetrant from the discontinuity to provide a contrasting indication on the surface. A liquid penetrant examination will only be performed when the eddy current examination cannot be performed due to the surface profile of a repair weld or some other prohibitive condition.

C. NB-2539.4 – Radiographic Examination of Repair Welds

NB-2539.4 requires a radiographic examination of base material repair welds when the depth of the repair cavity exceeds the lesser of 3/8" or 10% of the section thickness. However, a radiographic examination of the repair weld cannot be performed.

Impracticality of Radiographic Examinations

Radiographic examination of weldments employs x-rays or gamma rays to penetrate an object and detect discontinuities by the resulting image on a recording or a viewing medium such as photographic film. When a weld is exposed to radiation, some of the radiation is absorbed, some scattered, and some transmitted through the weldment to the film. The variations in amount of radiation transmitted through the weld depend on (1) relative densities of the material and any inclusions, (2) through-thickness variations, and (3) the characteristic of the radiation itself. Nonmetallic inclusions, pores, aligned cracks, and other discontinuities result in more or less radiation reaching the recording film. The variations in transmitted radiation produce optically contrasting areas on the recording film.

Radiography is not appropriate for base material weld repairs of RPV penetration nozzles. Radiographic techniques require that the source of radiation be placed as near normal to the item being examined as possible, with the film in intimate contact with the item on the opposite surface. An attempt to radiograph repair welds in the RPV penetration nozzles would have the radiation source being placed at various angles other than normal, penetrating from fractions of an inch of material thickness up to multiple inches of material thickness. Image quality indicators (penetrameters) would have to be placed on the inside bores of the RPV penetration nozzles. Multiple exposures would be required, and the image distortion would increase as the repair weld moved up the nozzle bore. The required radiographic sensitivity and geometric unsharpness would also not be obtainable with generally used radiographic techniques. Depending on the location of the repair weld, access to both surfaces of the RPV nozzle may not be available to allow radiographic examinations. In other cases, clearances between the RPV nozzles and the RPV head would make radiography of a repair weld impossible. Multiple exposures, complex geometry and thickness, and the adverse radiological environment make radiographic examination of RPV penetration nozzle repair welds impractical.

Suitability of Proposed Alternative

Meaningful radiographic examination of repair welds in RPV penetration nozzle base materials cannot be performed. As an alternative, Entergy proposes to utilize the ultrasonic and eddy current examination methods. The ultrasonic examination method will use a combination of Time of Flight Diffraction (TOFD) and standard 0° pulse-echo techniques. These examination methods are discussed in more detail in Section IV.A, above.

V. CONCLUSION

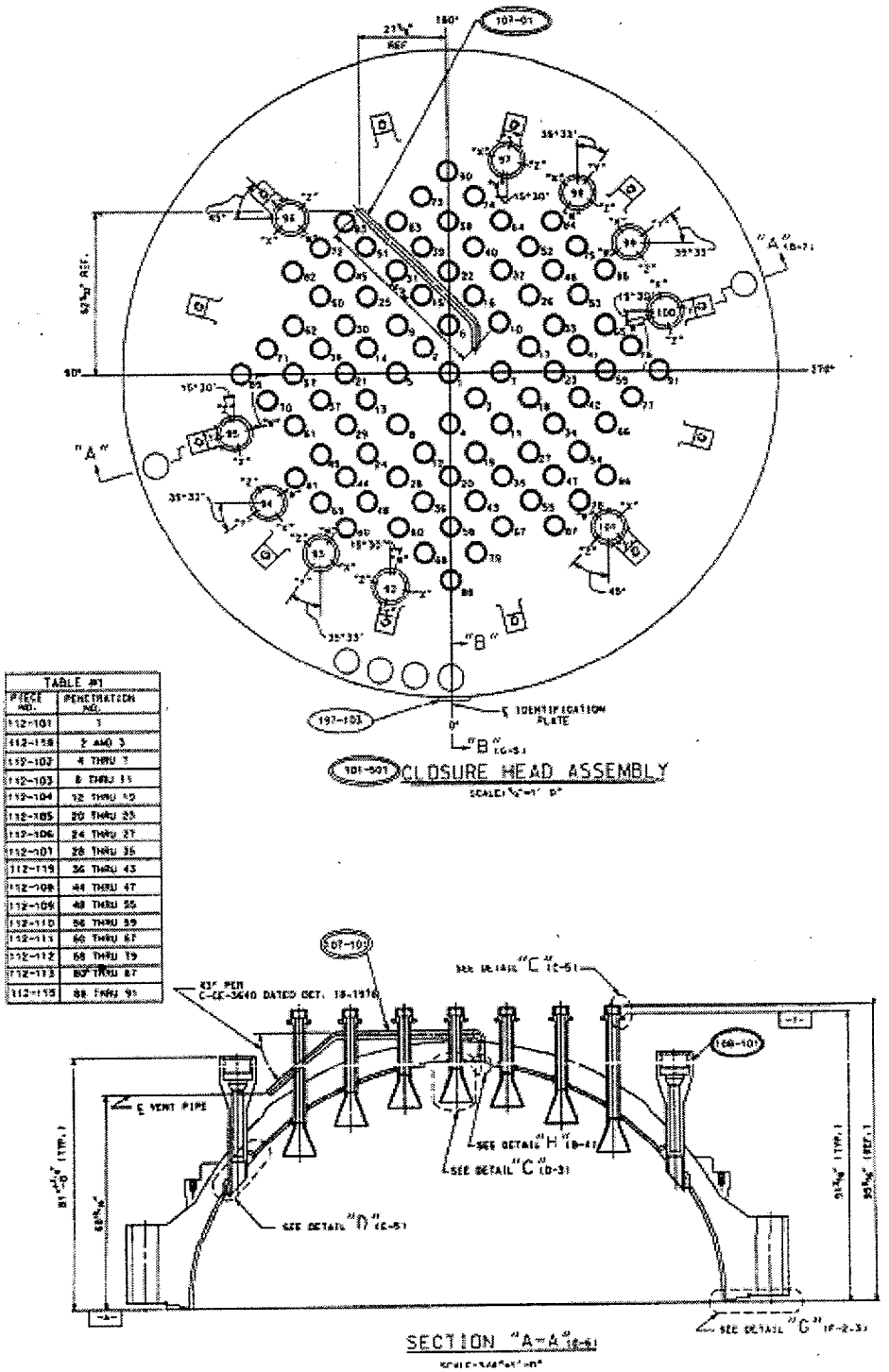
10CFR50.55a(g)(5)(iii) states:

"If the licensee has determined that conformance with certain code requirements is impractical for its facility, the licensee shall notify the Commission and submit, as specified in 50.4, information to support the determinations."

10CFR50.55a(g)(6)(i) states:

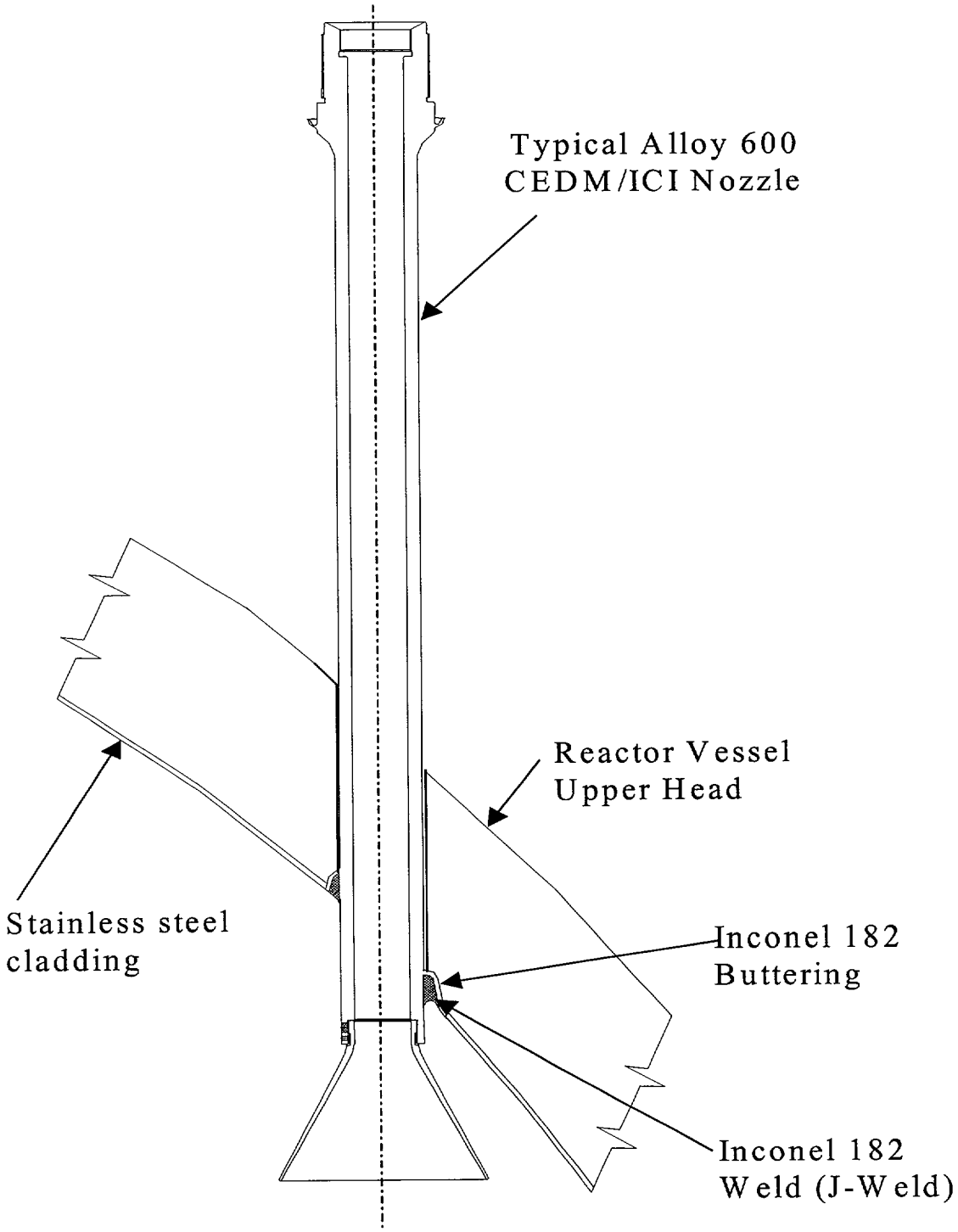
"The Commission will evaluate determinations under paragraph (g)(5) of this section that code requirements are impractical. The Commission may grant such relief and may impose such alternative requirements as it determines is authorized by law and will not endanger life or property or the common defense and security and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility."

As discussed in this request, Entergy believes the examinations required by ASME Section XI IWA-4331(a) and Section III NB-2539.4 for base material weld repairs are impractical since they cannot be performed. Entergy has proposed alternative examination methods that we believe provide an acceptable level of quality and safety. Therefore, we request the proposed request for relief be authorized pursuant to 10CFR50.55a(g)(6)(i).



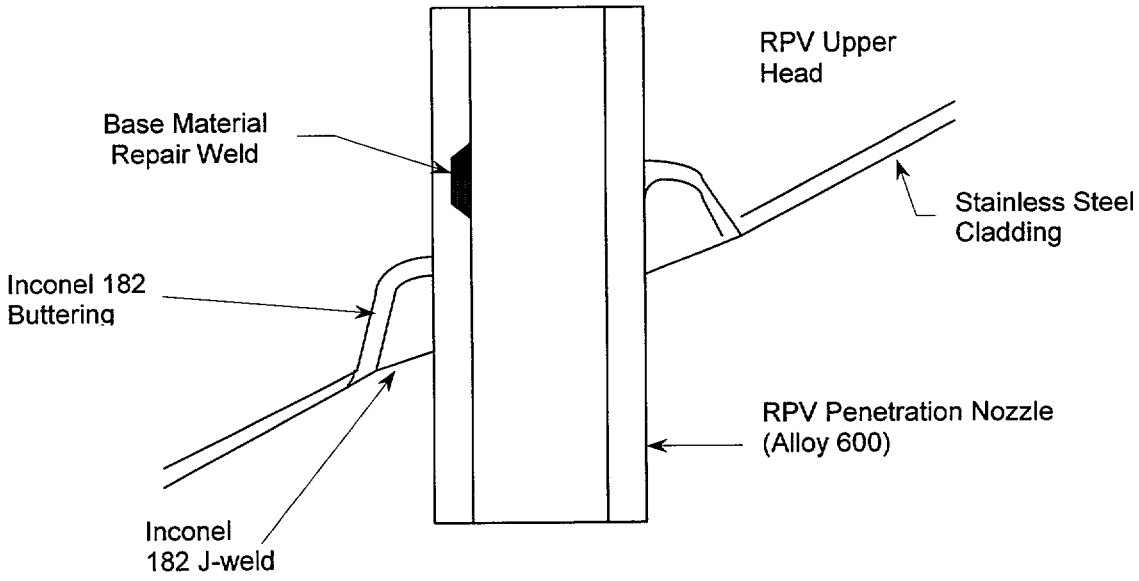
Waterford 3 RPV Penetration Nozzles

FIGURE 1



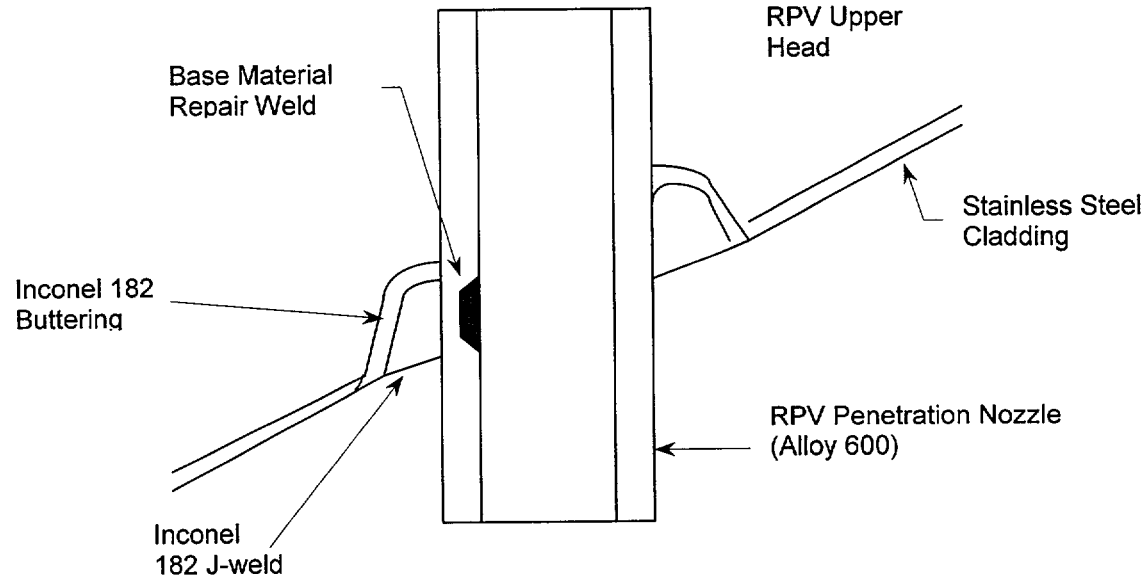
Typical RPV Penetration Nozzle

FIGURE 2



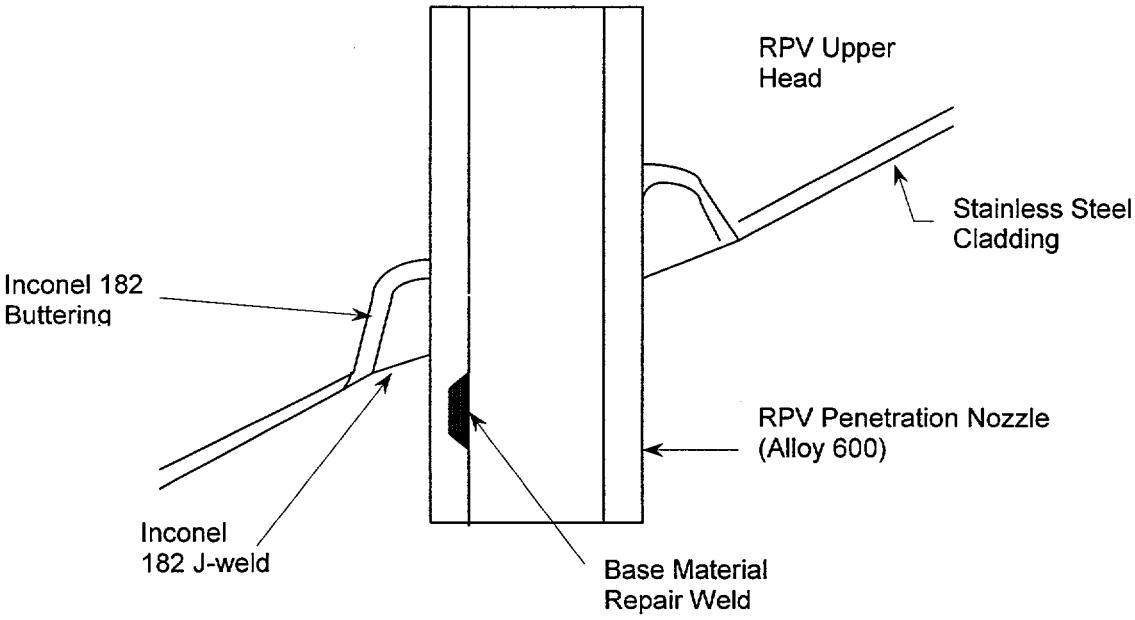
RPV Nozzle Repair Weld: Inside Diameter and Above J-Weld

Figure 3



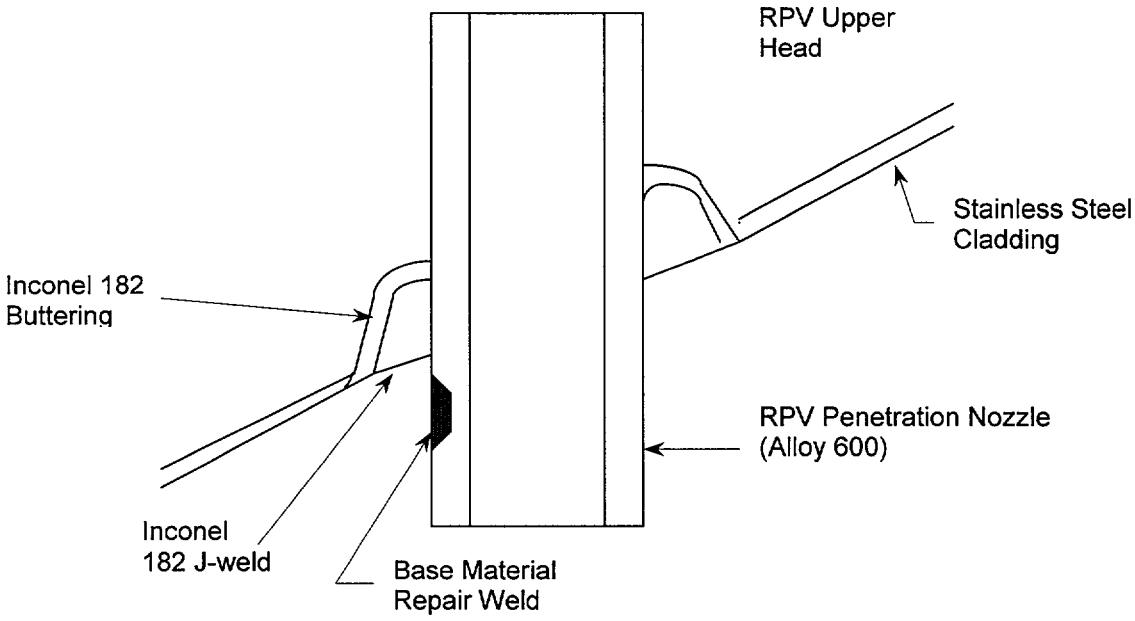
RPV Nozzle Repair Weld: Inside Diameter and Adjacent to J-Weld

Figure 4



RPV Nozzle Repair Weld: Inside Diameter and Below J-Weld

Figure 5



RPV Nozzle Repair Weld: Outside Diameter and Below J-Weld

Figure 6