March 25, 2008

Vice President, Operations
Entergy Operations, Inc.
Waterford Steam Electric Station, Unit 3
17265 River Road
Killona, LA 70057-3093

SUBJECT: WATERFORD STEAM ELECTRIC STATION, UNIT 3 - REQUEST FOR RELIEF W3-ISI-004, ALTERNATIVE TO REQUIREMENTS TO ALLOW EXTENSION TO SECOND 10-YEAR INSERVICE INSPECTION INTERVAL BEYOND THAT CURRENTLY ALLOWED BY ASME CODE, PARAGRAPH IWA-2340(D) (TAC NO. MD6351)

Dear Sir or Madam:

Pursuant to Title 10 of *Code of Federal Regulations* (10 CFR), Section 50.55a(a)(3), Entergy Operations, Inc. (the licensee), submitted, by letter dated August 7, 2007, as supplemented by letter dated December 11, 2007, an alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements, W3-ISI-004, to allow for an extension to the Waterford Steam Electric Station, Unit 3 (Waterford 3), second 10-year inservice inspection (ISI) program interval beyond that currently allowed by the paragraph IWA-2430(d) of the ASME Code, Section XI, until refueling outage 16 (RF16) in 2009. During RF16, the licensee has committed to either performing ultrasonic examinations using accepted techniques for examination of dissimilar metal welds involving cast stainless steel, or installing preemptive weld overlays.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal and determined that compliance with the specified requirement would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety and the proposed alternative provides reasonable assurance of structural integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes the use of the proposed alternative with one commitment, for the examination of the seven welds identified within the alternative. The effective period of the proposed alternative is until Waterford 3's RF16, currently scheduled to start in the fall of 2009.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

The staff's safety evaluation is enclosed.

Sincerely,

/RA/

Thomas G. Hiltz, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

The staff's safety evaluation is enclosed.

Sincerely,

/RA/

Thomas G. Hiltz, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure: Safety Evaluation

cc w/encl: See next page

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ADAMS Accession No. ML080510161 (*) Minor editorial changes made from staff-provided SE (**) See previous concurrence

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SAFETY EVALUATION REPORT

REQUEST FOR ALTERNATIVE W3-ISI-004

ALTERNATIVE TO SECOND 10-YEAR ISI INTERVAL EXAMINATIONS

WATERFORD STEAM ELECTRIC STATION UNIT 3

ENTERGY OPERATIONS, INC.

DOCKET NUMBER 50-382

1.0 INTRODUCTION

By letter dated August 7, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML072220121), and supplemented by letter dated December 11, 2007 (ADAMS Accession No. ML073461088), Entergy Operations, Inc. (Entergy, the licensee), requested U.S. Nuclear Regulatory Commission (NRC) staff review and approval of Request for Alternative W3-ISI-004 as an alternative to the inspection requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-2430(a) and IWB-2500(a) for seven dissimilar metal welds (DMW) found in the reactor coolant system (RCS) cold-leg piping at Waterford Steam Electric Station, Unit 3 (Waterford 3).

Entergy is submitting W3-ISI-004 as a result of a discussion with the NRC staff regarding the previously submitted Request for Alternative W3-ISI-002. Pursuant to W3-ISI-002, Entergy requested approval to extend the second inservice inspection (ISI) interval for piping welds at Waterford 3 to the end of its 16th refueling outage (RF16), currently scheduled for the fall 2009. The requested extension was for approximately 17 months beyond the 1-year extension allowed by ASME Code, Section XI, IWB-2412(b). Entergy based the extension on guidance provided in NRC Information Notice 98-44 (IN 98-44). The NRC staff informed Entergy that this extension was beyond that specified in IN 98-44 and, therefore, the staff would not be able to grant the request. However, the staff informed Entergy that specific welds for which inspection resulted in a hardship or unusual difficulty in accordance with section 50.55a(a)(3)(ii) of Title 10 of the *Code of Federal Regulations* (10 CFR) would be appropriate for considering an extension. Hence, Entergy submitted W3-ISI-004 for such welds and withdrew previously submitted W3-ISI-002.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 120-month interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

Pursuant to 10 CFR 50.55a(a)(3) alternatives to requirements may be authorized by the NRC if the licensee demonstrates that: (i) the proposed alternatives provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.0 PROPOSED ALTERNATIVE W3-ISI-004

3.1 Components Affected

Alternative W3-ISI-004 affects the following components:

Component/Weld Number	Component/Weld Description
11-012	Weld in 1RC30-9RL2A, Loop 2A Reactor Coolant Pump (RCP) 2A Suction from Steam Generator (SG) 2
12-012	Weld in 1RC30-5RL2A, Loop 2A From RCP 2A to Reactor Vessel
13-016	Weld in 1RC30-10RL2B, Loop 2B RCP 2B Suction from SG 2
14-002	Weld in 1RC30-6RL2B, Loop 2B From RCP 2B to Reactor Vessel
10-008	Weld in 1RC12-38RL1B, Safety Injection (SI) System Tie to Reactor Coolant (RC) Cold Leg 1B
12-009	Weld in 1RC12-39RL2A, SI System Tie to RC Cold Leg 2A
14-006	Weld in 1RC12-40RL2B, SI System Tie to RC Cold Leg 2B

3.2 Applicable Code Requirements (as stated)

The inservice examination of welds at Waterford 3 is currently performed in accordance with the 1992 Edition of ASME Section XI with the exception of ultrasonic examinations, which are performed in accordance with the 1995 Edition/1996 Addenda. The following code requirements are applicable to this request.

- IWA-2430(a) requires that "inservice examinations and system pressure tests required by IWB, IWC, IWD, IWE, and inservice examinations and tests of IWF shall be completed during each of the inspection intervals for the service life-time of the plant."

- IWB-2500(a) requires that the examination and testing of Class 1 component welds and materials be performed in accordance with Table IWB-2500-1. Inservice examination requirements for pressure-retaining welds [including DMWs] in piping are addressed under Examination Category B-J of Table IWB-2500-1. These requirements include the following provisions:

  - Twenty-five (25) percent of all Examination Category B-J welds must be examined using surface or volumetric examination methods during each inspection interval. According to Note (1)(c) of Table IWB-2500-1, the selected population for inservice examination must include all DMWs.

  - Inservice examination areas and volumes must comply with coverage requirements of Figure IWB-2500-8 except that a 10 percent reduction in coverage is allowed as specified in ASME Code Case N-460. (The NRC has approved Code Case N-460 for use, as documented in Regulatory Guide 1.147.)

3.3 Proposed Alternatives and Basis

3.3.1 Proposed Alternative (as stated)

Pursuant to 10 CFR 50.55a(a)(3)(ii), Entergy proposes the following as an alternative to the code requirements of ASME Section XI, IWA-2430(a) and IWB-2500(a) as described in Section 3.2 above. The proposed alternative is applicable to the seven Examination Category B-J DMWs identified in Section 3.1.

1. Perform a bare metal visual examination during the upcoming refueling outage (RF) 15 using personnel qualified to perform VT-2 visual examinations in accordance with ASME Section XI, IWA-2300.

2. Perform one of the following actions during RF16:

   a. Perform ultrasonic examinations using NRC-accepted techniques for inspecting DMWs involving cast stainless steel; or

   b. Install preemptive structural weld overlays. The proposed weld overlays will be installed using primary water stress-corrosion cracking (PWSCC)-resistant weld metal such as Alloy 52/52M.

To support option b, Entergy will submit for NRC staff approval a request for alternative that specifies the requirements applicable to the design, fabrication, examination, and inservice examination of the proposed preemptive weld overlays. This commitment is scheduled to be complete by October 2008.

3.3.2 Proposed Basis (as stated)

Seven Examination Category B-J welds requiring inservice examination during RF15 [refueling outage 15] cannot be examined (i.e., cannot meet the coverage requirements) as specified by ASME Section XI. These seven welds are Alloy 82/182 DMWs and are located in the cold-leg piping of the RCS. The inability to comply with the coverage requirements of ASME Section XI is due to weld conditions which inhibit performing ultrasonic examination using ASME Section XI, Appendix VIII procedures qualified in accordance with the Performance Demonstration Initiative (PDI) program. The hardship associated with this condition is described in Section III, above. As a result, Entergy proposes an alternative to the inservice examination requirements of ASME Section XI, IWA-2430(a) and IWB-2500(a).

Entergy proposes to perform a bare metal visual examination of the subject welds during RF15. This bare metal visual examination will be performed using personnel qualified to perform VT-2 visual examinations in accordance with ASME Section XI, IWA-2300.

4.0 TECHNICAL EVALUATION

The licensee has requested a one-cycle extension for the inspection of seven DMWs at Waterford 3. The examinations are required to be completed by the end of the second 10-year inservice inspection interval, which after invoking the Code-allowed one-year extension ends in June 2008. The licensee has submitted the request pursuant to 10 CFR 50.55a(a)(3)(ii) stating that the examinations required by ASME Code, Section XI, IWA-2430(a) and IWB-2500(a), on the identified seven Examination Category B-J welds during RF15 poses a hardship or unusual difficulty without a compensating increase in the level of quality and safety. The hardship is based on the current inability to achieve required ASME Code, Section XI, volumetric coverage requirements, partly caused by the inability to examine portions of the required inspection volume which are cast stainless steel, and also based on the extensive effort to inspect these welds that would result in more than doubling the planned outage time and additional radiation exposure during the upcoming RF15 at Waterford 3.

4.1 General Requirements

Paragraph 50.55a(g)(4) of 10 CFR requires that throughout the service life of a pressurized water-cooled nuclear power facility, components, including supports which are classified as ASME Code Class 1, must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI. The welds for which a one-cycle extension was requested by the licensee are designated as ASME Code Class 1 welds. ASME Code, Section XI, IWB-2500 requires that components be examined and tested as specified in Table IWB-2500-1. Examination Category B-J is applicable to pressure retaining welds in piping. Note (1)(c) of Table IWB-2500-1, Examination Category B-J, “Pressure Retaining Welds in Piping,” requires all dissimilar welds not covered under Category B-F to be inspected.

IWA-2232 of ASME Code, Section XI, 1992 Edition requires ultrasonic examination to be conducted in accordance with Appendix I. Appendix I, I-2220, for welds in piping, requires ultrasonic examination procedures, equipment, and personnel used to detect and size flaws in piping welds to be qualified by performance demonstration in accordance with Appendix VIII. 10 CFR 50.55a(g)(6)(ii)(C) requires implementation of Appendix VIII, Supplement 10 of the 1995 Edition, with the 1996 Addenda, by November 22, 2002.

4.2 Inspection Hardship

The seven welds, for which a one-cycle extension for the examination is requested, join stainless steel nozzles or carbon steel piping/fittings to cast stainless steel products. The required inspection volume is defined by either of the two figures IWB-2500-8. This volume is the inner one-third of the weld and includes part of the base material on each side of the weld. For the seven welds for which the one-cycle extension for the examination is requested, the base material on one side of the weld is cast stainless steel. ASME Code, Section XI, Appendix VIII does not have rules established for cast stainless steel. Table VIII-3110-1 indicates that the supplement for cast austenitic piping welds is in the course of preparation. Article VIII-3000 specifies that for piping welds whose requirements are in course of preparation, the requirements of Appendix III, as supplemented by Table I-2000-1, shall be met, for both sizing and detection. Table I-2000-1 invokes various ASME Code, Appendix I supplements for calibration blocks, pulse repetition rate, scan overlap, reflectors, etc. Appendix III defines the ultrasonic examination methods, equipment, and requirements applicable to piping systems. Appendix III invokes the additional requirements of Supplement 4 for examination of austenitic welds and DMWs. Appendix III, Supplement 4 provides additional requirements for scanning and recommends that examiners and procedures be qualified using welded samples, and simulated or actual flaws, or both, located in positions where geometry may make them more difficult to detect (e.g., the break in counterbore or adjacent to the weld root). The purpose of the examination procedure qualification is to determine that the proposed examination technique is capable of detecting the specified flaws of interest and that its capabilities and limitations will be identified. Supplement 4 states that the requirements for the qualification of examiners and procedures are in the course of preparation.

4.2.1 Alternatives Considered and Hardship

In order to be able to inspect the seven DMWs, the licensee determined that they would need to either modify the weld configuration to improve the inspection coverage, install a preemptive structural weld overlay during RF15, or perform a best-effort inservice examination.

Modify Weld Configuration to Improve Inspection Coverage

Entergy had the Electric Power Research Institute (EPRI) evaluate all the DMWs at Waterford 3 including the seven welds for which extension is requested. The EPRI evaluation concluded that examination of the seven welds would not be able to meet the coverage requirements of ASME Section XI as defined in Figure IWB-2500-8. The estimated coverage that could be obtained is shown in the following table:

ISI Weld Number	Axial Scan Coverage	Circumferential Scan Coverage
11-002	18 percent	57 percent
12-012	89 percent	86 percent
13-016	46 percent	63 percent
14-002	43 percent	47 percent
10-008	54 percent	6 percent
12-009	55 percent	43 percent
14-006	55 percent	44 percent

Entergy does not believe that coverage could be increased to 90 percent even with extensive machining and welding to build up areas. In order to obtain coverage greater than 90 percent, new inspection techniques would need to be developed to examine DMWs involving cast austenitic stainless steel. Mock-ups would need to be fabricated that include cast stainless steel safe-ends. New examination procedures would need to be qualified, as well as personnel to examine welds to cast stainless steel products. The licensee states that this scope of work cannot be completed prior to the RF15.

Install Preemptive Structural Weld Overlays During RF15

Entergy has considered the installation of preemptive structural weld overlays using Alloy 52/52M weld metal on the subject welds. Entergy considers this method to be an acceptable approach, but not a viable approach for RF15, as Entergy already plans to install preemptive weld overlays on nine DMWs associated with the Waterford 3 pressurizer, surge line, and hot-leg nozzles during RF15. Due to their exposure to high operating temperatures, the susceptibility of these nine DMWs to PWSCC is highest among the DMWs within the RCS. Entergy considers installing weld overlays onto the high-temperature DMWs of the highest priority and consistent with industry guidance in MRP-139.

Entergy estimates that to perform the weld overlays on an additional seven cold-leg nozzles will add approximately 30 additional days to the current refueling outage duration of 25 days.

Perform a “Best Effort” Examination

Entergy considered performing a "best effort" inservice examination of the subject welds. However, Entergy already plans to ultrasonically examine the subject seven welds using NRC-accepted examination techniques that have the capability to examine DMWs involving cast stainless steel, during the fall 2009 refueling outage at Waterford 3 (RF16). While the

technology to ultrasonically examine DMWs in cast stainless steels has not yet been developed, Entergy is working with the industry to resolve that issue. Should the inspection technology be developed in time for new procedures and personnel to be qualified by RF16, Entergy plans to ultrasonically examine these welds using the newly developed techniques.

If the ultrasonic inspection technology described above is not developed in time to support RF16, preemptive structural weld overlays will be installed on the subject seven welds. Entergy would take this step as a proactive measure to address PWSCC concerns and improve structural integrity of the RCS pressure boundary. The weld overlays would be installed using Alloy 52/52M Weld metal based on ASME Code Case N-740, which has not yet been approved by the NRC. The acceptance and pre-service examinations of the weld overlays would also be performed using ultrasonic procedures qualified in accordance with ASME Code, Section XI, Appendix VIII as implemented by the PDI.

4.3 Evaluation of Hardship

Inspection Difficulties

It is the NRC staff position, for ultrasonic examination of piping butt welds, that performance demonstration is necessary to ensure examinations are capable of finding defects and flaws in welds. As described above, the ASME Code does not currently contain instructions for performance demonstration of cast stainless steel in the ASME Code, Section XI, 1995 Edition through the 1996 Addenda, Appendix VIII, as the rules are in the course of preparation. Requirements for the examination of cast stainless steel in later editions of the ASME Code are also still in the course of preparation. There are no procedures available that have been demonstrated to be able to detect flaws in cast stainless steel materials. Therefore, the licensee cannot examine the cast stainless steel using performance demonstration requirements at this time.

Hardship Associated with Alternatives

Modification of the weld profile would require grinding and/or machining of the surface and possibly welding to fill in areas to establish a weld profile acceptable for implementation of the examination procedures. This would result in increased radiological dose to the workers and the potential for outage delays. Even with the modification of the weld surface profile, the licensee would still be faced with the task of inspecting cast stainless steel which is within the required examination volume. As there are no examination procedures qualified at this time to examine cast stainless steel, the licensee will not be able to achieve the required examination coverage.

If the licensee were to install preemptive structural weld overlays during RF15, there would be significant time required prior to RF15 to complete the necessary engineering, mock-up development, procedure qualification, equipment qualification, or personnel qualification. The vendors that provide the services for weld overlay are limited to a relatively small number, four to five. The number of welders available for weld overlay application is small. The installation of nine weld overlays on the pressurizer and RCS hot-leg DMWs will require a longer commitment of welding resources. The dissimilar metal butt welds located in the pressurizer and RCS hot legs are appropriately being treated as the highest priority locations with regard to

mitigation of PWSCC. The overlay of seven additional welds, some of which are of larger diameter and thickness than the nine already planned for RF15, will result in higher dose received to the welders and inspection personnel. Significant additional welder and inspection person-hours would be needed if these seven additional overlays were installed during RF15. An estimated additional 20 roentgen equivalent man (rem) radiological dose would be accrued to install the overlays during RF15.

In the performance of a "best effort" examination, the licensee still would not be able to achieve the required examination coverage, and would not meet the requirements of the ASME Code, Section XI. The best effort examination would employ ultrasonic examination procedures in accordance with ASME Code, Section XI, Appendix III, which are not yet demonstrated to find inservice flaws. Therefore, this examination could not be relied upon to provide any additional quality or safety to the examination. Also, with the actions the licensee has planned, the additional radiological dose to perform the "best effort" examinations would not be warranted.

The primary degradation mechanism for the seven Examination Category B-J DMWs is PWSCC. The licensee used MRP-109 as a basis for why the susceptibility of these welds to PWSCC is low, citing that the driving force for axial flaws and circumferential flaws is approximately the same for shallow flaws. For flaws with depths greater than 15 to 20 percent of the wall thickness, the hoop stresses dominate. For flaws with depths greater than 45 percent of the wall thickness, the hoop stresses are about twice that of axial stresses. However, while the NRC recognizes that the stress intensity is the driving force for flaw growth, the stress profile within a weld is dependent on many factors including sequence of welding, repairs, machining, post-weld heat treatment, welds between the safe-end and field piping, etc., and that there are many unknown factors when trying to determine the stress profile. Therefore, stress profiles for these welds were considered by the staff, but were not a sufficient reason on their own to support the extension of the weld inspections.

Temperature has long been recognized as a significant factor for assessing the susceptibility of an Alloy 82/182 weld to PWSCC. The 50 to 70 degrees Fahrenheit (°F) temperature difference between hot and cold legs is enough to significantly influence the time to initiation and subsequent rate of PWSCC degradation. Operational experience shows that, for the same material susceptibility and stress level, PWSCC occurs more frequently and propagates more rapidly in pressurizer penetrations at 650 °F than in hot-leg penetrations at 600 °F to 620 °F. Similarly, PWSCC is less likely to occur in cold-leg temperature penetrations at about 550 °F. The welds that are the subject of this relief request are in the cold-leg piping. Therefore, the NRC staff has reasonable assurance that the structural integrity of these welds will be maintained until RF16.

While the more vulnerable nine DMWs associated with the Waterford 3 pressurizer, surge, and hot-leg nozzles, will be installed with preemptive structural weld overlays during RF15, the licensee states that the less susceptible seven welds, identified in Section 3.1, will be installed with structural weld overlays during RF16, since these are exposed to the lower operating temperatures (and, therefore, a lower susceptibility to PWSCC).

Industry representatives recognize the potential for PWSCC of these welds and have developed the Materials Reliability Program: "Primary System Piping Butt Weld Inspection and Evaluation Guidelines (MRP-139NP)," to address butt welds in primary-water systems piping that are

1 inch nominal pipe size or greater that operate at temperatures greater than or equal to cold-leg temperatures. The proposed alternatives of W3-ISI-004 are consistent with these guidelines.

Licensee's Commitment

To support this action, Entergy commits to the following, "[to] support the option of installing weld overlays, Entergy will submit for NRC staff approval a request for alternative that specifies the requirements applicable to the design, fabrication, examination, and inservice examination of the proposed preemptive weld overlays." This commitment is scheduled to be complete by October 2008.

The staff finds Entergy's commitment allows for a timely resolution for the outstanding inspection hardship issues identified for the seven cold-leg temperature DMWs. Effective inspection and/or mitigation of these welds within reasonable as-low-as-reasonably-achievable guidelines is the NRC staff's purpose in authorizing this alternative. Entergy's commitment to take action on this issue by October 2008 provides confidence that successful action, whether inspection or mitigation, will take place in RF16.

The NRC staff finds that reasonable controls for the implementation and for subsequent evaluation of proposed changes pertaining to the regulatory commitments are best provided by the licensee's administrative processes, including its commitment management program. The regulatory commitments do not warrant the creation of regulatory requirements (items requiring prior NRC approval of subsequent changes).

Given the terms of the proposed alternative, and as the susceptibility of these welds to PWSCC is lower based on the operating temperature, the inability to conduct an ultrasonic examination based on performance demonstrations, and the additional radiological dose that would be accrued either through examination, weld overlay, or modification to the weld profile, the NRC staff has found that inspection of the seven welds during RF15 does present a hardship without a compensating increase in the level of quality and safety.

5.0 CONCLUSION

The NRC staff has reviewed Entergy's submittal and commitment and determined that examination of the seven welds identified in Alternative W3-ISI-004 does result in a hardship or unusual difficulty during the 15th refueling outage without a compensating increase in the level of quality and safety. Due to the lower susceptibility of the seven welds, the proposed alternative provides reasonable assurance of structural integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes the use of the Alternative W3-ISI-004 with one commitment, for the examination of the seven welds identified within the alternative. The effective period of Alternative W3-ISI-004, is through the completion of the Waterford 3 RF16, currently scheduled to start in the fall of 2009.

The licensee commits to the following:

> To support the option of installing weld overlays, Energy will submit for NRC staff approval a request for NRC staff approval a request for alternative that specifies the requirements applicable to the design, fabrication, examination, and inservice examination of the proposed preemptive weld overlays.

This commitment is scheduled to be complete by October 2008.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: J. Collins

Date: March 25, 2008