UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 31, 2013

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 ALTERNATIVE W3-ISI-020, ASME CODE CASE N-770-1 BASELINE EXAMINATION (TAC NO. ME9801)

Dear Sir or Madam:

By letter dated October 16, 2012, as supplemented by letters dated November 15 and December 16, 2012, Entergy Operations, Inc. (the licensee), submitted for the U.S. Nuclear Regulatory Commission (NRC) review and authorization Request for Alternative W3-ISI-020, "ASME [American Society of Mechanical Engineers] Code Case N-770-1 Baseline Examination Request for Alternative," for Waterford Steam Electric Station, Unit 3 (Waterford 3). The request is associated with the use of an alternative to the requirements of the ASME Boiler and Pressure Vessel Code, Code Case N-770-1, in accordance with Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR 50), paragraph 55a(g)(6)(ii)(F)(3), dated June 21, 2011. The licensee also stated that the alternative is for the current third 10-year ISI interval.

Specifically, the licensee is proposing to credit a previous examination of nickel-based Alloy 82/182 dissimilar metal butt welds to satisfy the baseline examination requirement of ASME Code Case N-770-1. The licensee requested authorization to use the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff determined that proposed alternative W3-ISI-020 provides reasonable assurance of structural integrity and leak tightness until the scheduled refueling outage in the spring of 2014, and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii) and, therefore, recommends authorization to use the proposed alternative at Waterford 3, until the scheduled refueling outage in the spring of 2014. Verbal authorization for use of the proposed alternative was given in a conference call between the NRC staff and the licensee's representatives on December 18, 2012.

Authorizing the use of the alternative, pursuant to 10 CFR 50.55a(a)(3)(ii), 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 that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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

The NRC staff authorizes the use of the alternative, detailed in this request, until the scheduled refueling outage in the spring of 2014.

The NRC staff's safety evaluation is enclosed.

Sincerely,

Michael T. Markley, 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: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ASME CODE CASE N-770-1 BASELINE EXAMINATION

ALTERNATIVE W3-ISI-020

ENTERGY OPERATIONS, INC.

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NO. 50-382

1.0 INTRODUCTION

By letter dated October 16, 2012, as supplemented by letters dated November 15 and December 16, 2012 (References 1, 2, and 3, respectively), Entergy Operations, Inc. (the licensee), submitted request for alternative W3-ISI-020, "ASME Code Case N-770-1 Baseline Examination Request for Alternative," for U.S. Nuclear Regulatory Commission (NRC) review and authorization. Specifically, the licensee is proposing to credit a previous examination of nickel-based Alloy 82/182 dissimilar metal butt welds (DMBW) to satisfy the baseline examination requirement of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Case N-770-1, as conditioned by Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR 50), paragraph 55a(g)(6)(ii)(F)(3), at Waterford Steam Electric Station, Unit 3 (Waterford 3). The licensee requested authorization to use the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Verbal authorization for use of the proposed alternative was given in a conference call between the NRC staff and the licensee's representatives on December 18, 2012 (Reference 4).

2.0 REGULATORY EVALUATION

Paragraph 55a(g)(6)(ii)(F) of 10 CFR 50 requires that licensees of existing operating pressurized-water reactors (PWRs) implement the requirements of ASME Code Case N-770-1, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities," subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (g)(6)(ii)(F)(10), by the first refueling outage after August 22, 2011.

Paragraph 55a(g)(6)(ii)(F)(3) of 10 CFR 50 states that

> Baseline examinations for welds in Table 1, Inspection Items A–1, A–2, and B, shall be completed by the end of the next refueling outage after January 20, 2012. Previous examinations of these welds can be credited for baseline examinations if they were performed within the re-inspection period for the weld item in Table 1 using Section XI, Appendix VIII requirements and met the Code required examination volume of essentially 100 percent. Other previous examinations that do not meet these requirements can be used to meet the baseline examination requirement, provided NRC approval of alternative inspection requirements in accordance with paragraphs (a)(3)(i) or (a)(3)(ii) of this section is granted prior to the end of the next refueling outage after January 20, 2012.

Paragraph 10 CFR 50.55a(a)(3) states, in part, that alternatives to the requirements of 10 CFR 50.55a(g) may be used when authorized by the NRC if the applicant demonstrates that: (i) the proposed alternatives would 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.

Based on analysis of the regulatory requirements, the NRC staff concludes that regulatory authority exists to authorize the proposed alternative pursuant to 10 CFR 50.55a(a)(3)(ii).

3.0 TECHNICAL EVALUATION

3.1 Licensee's Request for Alternative

3.1.1 Components Affected

ASME Code Class 1 dissimilar metal piping welds containing Alloy 82/182, ASME Code Case N-770-1 Inspection Item B, unmitigated butt weld at cold leg operating temperature.

The dissimilar metal piping welds covered by this relief request are identified in the Attachment 2, "Weld Data Table," to the licensee's letter dated December 16, 2012 (reproduced in the Attachment to this safety evaluation):

> Reactor coolant pump (RCP) inlet weld numbers: 07-002; 09-016; 11-002; and 13-016
>
> RCP outlet weld numbers: 08-014; 10-002, 12-002; and 14-002
>
> Safety injection nozzle to safe end weld numbers: 08-009; 10-008; 12-009; and 14-006

3.1.2 Code Requirements

The Waterford 3, Code of record for the third 10-year inservice inspection (ISI) interval that started on June 1, 2012 and is scheduled to end on July 1, 2017, is the 2001 Edition through the 2003 Addenda of the ASME Code, Section XI.

The subject welds are classified as Inspection Item "B," "Unmitigated butt weld at Cold Leg operating temperature ≥ 525° F and < 580° F" for which visual and essentially 100 percent volumetric examinations are required.

3.1.3 Licensee's Reason for Request

The licensee stated that the ultrasonic testing (UT) examination of the subject welds in the fall of 2009 did not obtain essentially 100 percent of the required examination volume coverage, and to obtain additional coverage would necessitate modification or replacement of the component.

3.1.4 Licensee's Proposed Alternative and Basis for Use

The licensee proposes to credit a previous examination of nickel-based dissimilar metal butt welds (DMBWs) performed in accordance with the requirements of Electric Power Research Institute (EPRI) technical report, "Material Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139, Revision 1)," December 2008 (Reference 5), in the fall of 2009 to satisfy the baseline examination requirement of ASME Code Case N-770-1, as conditioned by 10 CFR 50.55a(g)(6)(ii)(F)(3). The licensee stated that the equipment, procedure, and personnel utilized for the examinations were qualified in accordance with the requirements of ASME Code, Section XI, Appendix VIII, as implemented through the Performance Demonstration Initiative (PDI) program, employing the best available technology for maximizing examination coverage of these types of welds, and that the examinations performed on the subject areas demonstrate an acceptable level of integrity.

The licensee has cited the following authorized relief requests as precedents:

1. Diablo Canyon Power Plant, Unit 1, dated February 24, 2012 (Reference 6).

2. Calvert Cliffs Nuclear Power Plant, Unit 1, dated December 19, 2012 (Reference 7).

3.2 NRC Staff Evaluation

Primary water stress-corrosion cracking (PWSCC) of nickel-based pressure boundary materials is a safety concern. Operational experience has shown that PWSCC can occur as the result of the combination of susceptible material, corrosive environment, and tensile stresses, resulting in leakage and the potential for loss of structural integrity. The subject DMBWs meet these conditions thus may be susceptible to PWSCC. The examination requirements of ASME Code Case N-770-1, as conditioned by 10 CFR 50.55a(g)(6)(ii)(F), are intended to ensure the structural integrity and leak tightness of DMBWs through nondestructive examination.

The subject dissimilar metal butt welds (DMBWs) are PWSCC-susceptible Alloy 82/182 weld metal joining mill-clad carbon steel (SA-516, Grade 70, with SA-240-304L cladding) to cast austenitic stainless steel (CASS, SA-351, Grade CF8M) safe-ends. The subject welds are located either on the 30-inch inside diameter (ID) reactor coolant pump (RCP) suction or discharge piping, or join a 12-inch outside diameter (OD) safety injection nozzle to each RCP spool piece.

The licensee stated that there is limited circumferential scan examination volume coverage for axial flaws in the susceptible material due to weld taper and the lack of access for examination from the CASS safe-end side of the welds. The licensee stated that the limitation for examination of the susceptible material is due to joint limitations and not surface conditioning; in order to obtain additional axial coverage, weld build up of the dissimilar metal butt weld would be required, along with additional contouring and an ASME Code, Section III, required radiographic (RT) examination. The NRC staff concludes that the efforts needed to obtain essentially 100 percent scan coverage of the susceptible material in the circumferential scan direction would present a hardship.

The licensee stated that the subject nozzle-to-safe-end welds were examined in accordance with MRP-139, Revision 1, in fall 2009. The UT examination was a manually-delivered non-encoded phased-array single-sided UT examination from the OD of the ferritic side of the weld in both the circumferential as well as axial directions. The UT procedure SI-UT-130, "Procedure for the Phased Array Ultrasonic Examination of Dissimilar Metal Welds" (included as Attachment 2 to Reference 2), and personnel were qualified to the requirements of ASME Code, Section XI, Appendix VIII, Supplement 10. The Performance Demonstration Qualification Summary (PDQS) No. 632, configuration "PWR (Combustion Engineering Design) – Reactor Coolant Pump Safe-end to Elbow Weld (717/X)" specifies that the procedure is not qualified to detect axial flaws on the far side of a single-side access component containing a tapered weld configuration.

The licensee stated that the 2009 examination achieved 100 percent examination coverage of the required ASME Code Case N-770-1 volume for axial and circumferential scans of the ferritic material and 100 percent axial scan coverage of the susceptible material for circumferential flaws for all of the subject welds. In its letter dated December 16, 2012, in response to the NRC staff's request for additional information (RAI), the licensee noted that the tapered weld limitation described in the PDQS did not exist for the four subject safety-injection welds and, accordingly, credited the 100 percent axial and circumferential scan coverage for the susceptible material of these welds. Due to the fact that CASS is not known to be susceptible to PWSCC or other service-related cracking in the reactor coolant system environment, the NRC staff concludes that the lack of ASME Code, Section XI, Appendix VIII-compliant examination of the CASS material is not a structural integrity concern. The NRC staff concludes that the complete examination coverage of the ferritic and susceptible material of the safety-injection nozzle to safe-end DMBWs and the best effort UT examination of the CASS material provide reasonable assurance of structural integrity and leak tightness and, therefore, the examinations of the safety injection DMBWs are acceptable.

The NRC staff has examined the drawings of the RCP DMBWs submitted by the licensee (Reference 3) and chose RCP outlet weld 08-014 as the bounding case based on circumferential scan coverage obtained and wall thickness.

In addition to the circumferential scans of the susceptible material in two scan directions from the carbon steel side of the RCP welds, the susceptible material in the weld volume has been sonically examined by circumferential scans in two scan directions from the weld crown. Pacific Northwest National Laboratory (PNNL) has modeled (Reference 8) the UT response in the susceptible weld material for scans performed from the weld crown of a similar weld geometry

using the parameters of the SI-UT-130 procedure. The evaluation included theoretical modeling of the sound beams based on actual phased-array design parameters and component geometry similar to that of weld 08-014. The PNNL model calculated the sound field extents and intensities for an isotropic material, as such, actual grain sizes and structures, velocity ranges, and other material variables that will affect sound beam attenuation, re-direction, and signal-to-noise values have not been applied, and in some cases, are unknown.

Adequate volumetric coverage exists for sound field intensity greater than or equal to -6 decibels (dB). The PNNL model determined that the -6 dB UT sound field did not extend to adequately interrogate the weld material at the ID surface, but the model predicted that the -6dB sound field extended to the uppermost tip of the assumed 10 percent hypothetical flaw in weld 08-014. Based on the PNNL model results for the scans performed from the weld crown, as well as the multiple scans from the ferritic side of the weld, the NRC staff concludes that there is a high likelihood of finding the hypothetical axial flaw size proposed by the licensee. Therefore, the hypothetical 10 percent deep flaw size proposed by the licensee is acceptable.

The licensee has submitted a flaw growth calculation for a hypothetical axial flaw growing by PWSCC in response to operational stress and the weld residual stress (WRS) that would result from a repair of 50 percent of the wall thickness. The licensee's analysis includes the effects of the WRS corresponding to an ID weld repair of 50 percent wall thickness without a subsequent post-repair heat treatment. The NRC staff concludes that the assumed 50 percent weld repair will likely bound any undocumented weld repair and that the absence of subsequent post-weld heat treatment reflects the condition of the weld. The parameters are, therefore, acceptable. The NRC staff compared the WRS values used in the calculation to reference WRS values and concludes that the licensee's WRS values are reasonable. Therefore, the WRS values for use in axial PWSCC flaw growth analysis are acceptable.

The NRC staff examined the geometry of the subject weld and concludes that it closely approximates and the weld geometry modeled. The licensee's states that a 16.7 percent through-wall flaw, significantly deeper than the proposed hypothetical 10 percent flaw through-wall flaw, would grow to the ASME Code allowable flaw size of 75 percent through-wall in approximately 54 months (Reference 7). The NRC staff notes that the safe-end length in the model is significantly longer than the actual safe-end length of weld 08-014 and that this presents a significant conservatism in the calculation.

The NRC staff performed independent confirmatory analyses using the proposed 10 percent through-wall hypothetical flaw size. The NRC staff's analyses used the licensee's calculated values for WRS for a 50 percent repair as well as reference WRS values for a 50 percent weld repair. The results of the NRC staff's analyses confirmed the licensee's calculation of 54 months to reach 75 percent through-wall ASME Code allowable size.

In summary, the NRC staff concludes that complying with the baseline examination requirements of 10 CFR 50.55a(g)(6)(ii)(F)(3) by performing an ASME Code-compliant examination of the subject RCP DMBWs would result in hardship. The NRC staff further concludes that the best effort UT examination of the CASS material and the UT scans from the carbon steel side of the weld and circumferential UT scans from the weld crown in the fall of 2009 provide reasonable assurance of structural integrity and leak tightness until the scheduled refueling outage in the spring of 2014. The NRC staff therefore concludes that complying with

refueling outage in the spring of 2014. The NRC staff therefore concludes that complying with the requirements of 10 CFR 50.55a(g)(6)(ii)(F)(3) would result in hardship without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

Based on the above, the NRC staff concludes that proposed alternative W3-ISI-020 provides reasonable assurance of structural integrity and leak tightness until the scheduled refueling outage in the spring of 2014, and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(ii) and, therefore, authorizes use of the proposed alternative at Waterford until the scheduled refueling outage in the spring of 2014.

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

5.0 REFERENCES

1. Mason, M. E., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Waterford 3 Request for Alternative W3-ISI-020, ASME Code Case N-770-1 Baseline Examination Request for Alternative," dated October 16, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML12296A241).

2. Mason, M. E., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Waterford 3 Response to an NRC Request for Additional Information (RAI) Associated with W3-ISI-020, Request for Alternative to ASME Code Case N-770-1 Baseline Examination [TAC No. ME9801]," dated November 15, 2012 (ADAMS Accession No. ML12324A170).

3. Mason, M. E., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Waterford 3 Supplemental Response to an NRC Request for Additional Information (RAI) associated with W3-ISI-020, Request for Alternative to ASME Code Case N-770-1 Baseline Examination [TAC No. ME9801]," dated December 16, 2012 (ADAMS Accession No. ML12352A172).

4. Kalyanam, N., U.S. Nuclear Regulatory Commission, "Waterford Steam Electric Station, Unit 3, Verbal Authorization of W3-ISI-020," dated December 18, 2012 (ADAMS Accession No. ML13085A125).

5. Electric Power Research Institute, "Material Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139, Revision 1)," December 2008 (ADAMS Accession No. ML100970671).

6. Markley, M. T., U.S. Nuclear Regulatory Commission, letter to John T. Conway, Pacific Gas and Electric Company, "Diablo Canyon Power Plant, Unit No. 1 – Approval of

Request for Relief NDE-RCS-SE-LP1CL to Allow Use of Alternative ASME Code Case N-770-1 (TAC No. ME7236)," February 24, 2012 (ADAMS Accession No. ML120530680).

7. Pickett, D., U.S. Nuclear Regulatory Commission, e-mail to Patricia S. Furio, Calvert Cliffs Nuclear Power Plant, LLC, "NRC Verbal Approval for Calvert Cliffs RR-ISI-04-06A," dated March 26, 2012 (ADAMS Accession No. ML120860541).

8. Pacific Northwest National Laboratory, Technical Letter Report, "Evaluation of Licensee's Alternative to 10 CFR 50.55a(g)(6)(ii)(F) for Limitations to Volumetric Examinations of Dissimilar Metal Welds, Entergy Operations, Inc., Arkansas Nuclear One, Unit 2," April 23, 2013 (ADAMS Accession No. ML13113A218).

9. Pyle, S. L., Entergy Operations, Inc., "Clarification on Initial Flaw Size and Qualified Examination Area, Revised Request for Alternative ANO2-ISI-007 Code Case N-770-1 Baseline Examination, Arkansas Nuclear One, Unit 2," dated December 17, 2012 (ADAMS Accession No. ML12354A203).

Principal Contributor: Jay Wallace

Date: May 31, 2013

Attachment:
Weld Data Table

ATTACHMENT

DISSIMILAR METAL PIPING WELDS COVERED
BY REQUEST FOR ALTERNATIVE W3-ISI-020

WATERFORD STEAM ELECTRIC STATION, UNIT 3

DOCKET NO. 50-382

Weld Data Table

Component ID	Component Description	MRP-139 Volume Coverage		N-770-1 Volume Coverage of PWSCC susceptible material			Tapered Weld PDQS Limitation	Fig (Note1)
		Axial Scan for Circ Flaws	Circ Scan for Axial Flaws	Axial Scan for Circ Flaws	PDQS qualified Circ Scan for Axial Flaws	Non-PDQS Qualified Circ Scan for Axial Flaws		
07-002	30" RCP 1A Inlet Elbow (CS) to Safe-end (Cast SS)	100%	80%	100%	84.8%	100%	Yes	501
08-014	30" RCP 1A Outlet Safe-end (Cast SS) to Pipe(CS)	100%	78%	100%	67%	100%	Yes	502
09-016	30" RCP 1B Inlet Elbow(CS) to Safe-end (Cast SS)	100%	83%	100%	68%	100%	Yes	501
10-002	30" RCP 1B Outlet Safe-end (Cast SS) to Pipe (CS)	100%	81%	100%	69%	100%	Yes	502
11-002	30" RCP 2A Inlet Elbow (CS) to Safe-end (Cast SS)	100%	80%	100%	65%	100%	Yes	501
12-012	30" RCP 2A Outlet Safe-end (Cast SS) to Pipe (CS)	100%	76%	100%	100%	100%	No	502
13-016	30" RCP 2B Inlet Elbow (CS) to Safe-end (Cast SS)	100%	79%	100%	67.2%	100%	Yes	501

Component ID	Component Description	MRP-139 Volume Coverage		N-770-1 Volume Coverage of PWSCC susceptible material			Tapered Weld PDQS Limitation	Fig (Note1)
		Axial Scan for Circ Flaws	Circ Scan for Axial Flaws	Axial Scan for Circ Flaws	PDQS qualified Circ Scan for Axial Flaws	Non-PDQS Qualified Circ Scan for Axial Flaws		
14-002	30" RCP 2B Outlet Safe-end (Cast SS) to Pipe (CS)	100%	80%	100%	67%	100%	Yes	502
08-009	12" RCS 1A CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
10-008	12" RCS 1B CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
12-009	12" RCS 2A CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A
14-006	12" RCS 2B CL, SI Nozzle to Safe-end (Cast SS)	100%	100%	100%	100%	100%	No	N/A

Note 1:
501 refers to Drawing 1201260.501 contained in Attachment 3
502 refers to Drawing 1201260.502 contained in Attachment 3

Authorizing the use of the alternative, pursuant to 10 CFR 50.55a(a)(3)(ii), 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 that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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

The NRC staff authorizes the use of the alternative, detailed in this request, until the scheduled refueling outage in the spring of 2014.

The NRC staff's safety evaluation is enclosed.

Sincerely,

/RA/

Michael T. Markley, Chief
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-382

Enclosure:
Safety Evaluation

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