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

January 28, 2014

Vice President, Operations
Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61N
St. Francisville, LA 70775

SUBJECT: RIVER BEND STATION, UNIT 1 – RELIEF REQUEST RBS-R&R-2013-001 PROPOSED ALTERNATIVE TO 10 CFR 50.55A POST-WELD HEAT TREATMENT (TAC NO. MF2733)

Dear Sir or Madam:

By letter dated August 19, 2012, as supplemented by letter dated October 17, 2013, Entergy Operations Inc. (Entergy, the licensee), requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, to permit previously replaced standby service water system valves not meeting the requirements of the construction code to remain in service for the life of each valve seat at River Bend Station, Unit 1 (RBS).

The licensee purchased 16 ASME Code Class 3 valves from Weir Valves and Controls Company USA, Inc., of which 10 valves have been installed. During fabrication, the welding process used to install stainless steel (P-Number 8) seats to carbon steel (P-Number 1) bodies of the subject valves did not fully comply with Table ND-4622.7(b)-1 of the ASME Code, Section III. The condition noted was that the base material was not preheated to 200 degrees Fahrenheit (minimum) as required by Table ND-4622.7(b)-1 for exemption from post-weld heat treatment. In accordance with paragraph 50.55a(a)(3)(ii) of Title 10 of the *Code of Federal Regulations* (10 CFR), the licensee proposed that the valves installed at RBS are capable of satisfactory performance without the application of elevated preheat or post-weld heat treatment and further proposed to allow the valves to remain in service for the life of each valve seat.

The U.S. Nuclear Regulatory Commission (NRC) staff determined that the proposed alternative provides reasonable assurance of structural integrity or leak tightness of the subject components 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). Therefore, the NRC staff authorizes the proposed alternative for the RBS through the useful life of the existing valve seats.

All other ASME Code, Section XI, requirements for which relief has not been specifically requested, remain applicable, including the third-party review by the Authorized Nuclear Inservice Inspector.

The NRC staff's safety evaluation is enclosed. If you have any questions, please contact Alan Wang at 301-415-1445 or via e-mail at Alan.Wang@nrc.gov.

Sincerely,

Douglas A. Broaddus, Chief
Plant Licensing IV-2 and Decommissioning
Transition Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-458

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF RBS-R&R-2013-001 FROM ASME CODE, SECTION XI,

TO PERMIT STANDBY SERVICE WATER SYSTEM VALVES NOT IN

COMPLIANCE WITH THE CONSTRUCTION CODE TO REMAIN IN SERVICE

ENTERGY OPERATIONS, INC.

RIVER BEND STATION, UNIT 1

DOCKET NO. 50-458

1.0 INTRODUCTION

By letter dated August 19, 2012 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13239A074) as supplemented by letter dated October 17, 2013 (ADAMS Accession No. ML13295A421), Entergy Operations, Inc. (the licensee), requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) to permit previously replaced standby service water system valves not meeting the requirements of the construction code to remain in service for the life of each valve seat at River Bend Station, Unit 1 (RBS).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(ii), the licensee requested relief from article IWA-4221(c) of Section XI of the ASME Code to permit the continued use of ASME Code Class 3 standby service water valves, which are not currently in compliance with the construction code (i.e., ASME Code, Section III, Table ND-4622.7), for the life of each valve seat 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.

This safety evaluation (SE) is related to the SE dated February 20, 2013 (ADAMS Accession No. ML13038A632), which approved RBS's relief request RBS-RR-2011-001 dated September 20, 2012 (ADAMS Accession No. ML12269A102), pertaining to the same valves of this relief request. In the September 20, 2012, relief request, the licensee proposed to replace these non-ASME Code compliant valves. The Division "2" valves identified in this submittal were to be replaced during refueling outage RF-18, which currently is scheduled for early 2015. The Division "1" valves identified in this submittal were to be replaced during RF-19, which currently is scheduled for early 2017. This approval will negate the need to replace these valves.

Enclosure

2.0 REGULATORY EVALUATION

Adherence to article IWA-4221(c) of Section XI of the ASME Code is mandated by 10 CFR 50.55a(g)(4), which states, in part, that throughout the service life of a boiling or pressurized water-cooled nuclear power facility, components (including supports) which are classified as ASME Code Class 1, Class 2, and Class 3 must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI of editions and addenda of the ASME Code.

The regulations in 10 CFR 50.55a(a)(3) state, in part, that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates (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 the above analysis, the NRC staff concludes that regulatory authority to authorize an alternative to article IWA-4221(c) of Section XI of the ASME Code, as requested by the licensee, exists.

3.0 TECHNICAL EVALUATION

3.1 Applicable Code Edition and Addenda

ASME Code, Section XI, 2001 Edition through 2003 Addenda
ASME Code, Section III, 1974 Edition / summer 1975 Addenda (construction code)
ASME Code, Section III, 1992 Edition / No Addenda (repair/replacement code – later edition of construction code)

3.2 Components for Which Relief is Requested

Component: Valves various sizes:

E12-MOVF068A, Residual Heat Removal Heat Exchanger Service Water Return

E12-MOVF068B, Residual Heat Removal Heat Exchanger Service Water Return

SWP-MOV506A, High Pressure Core Spray Diesel Generator Engine Water Heat Exchange Service Water Header Isolation

SWP-MOV506B, High Pressure Core Spray Diesel Generator Engine Water Heat Exchange Service Water Header Isolation

SWP-MOV501A, Reactor Closed Cooling Water Heat Exchanger Service Water Supply Header Isolation Valve

SWP-MOV501 B, Reactor Closed Cooling Water Heat Exchanger Service Water Supply Header Isolation Valve

SWP-MOV511A, Normal Service Water Return Isolation

SWP-MOV511B, Normal Service Water Return Isolation

SWP-MOV55A, Standby Service Water Cooling Tower 1 Inlet

SWP-MOV55B, Standby Service Water Cooling Tower 1 Inlet

ASME Code Class: Class 3

3.3 Reason for Request

In its letter dated August 19, 2013, the licensee stated, in part, that

> Entergy River Bend Station (RBS) purchased sixteen (16) ASME Class 3 valves from Weir Valves and Controls Company USA, Inc. All 16 valves, were stamped and certified to be in compliance with ASME Section III. Ten of these valves..., have been installed at RBS....
>
> On 8/2/2011, a letter was received from Weir Valves and Controls Company USA. The letter indicated that, during fabrication, the welding process used to install stainless steel (P-Number 8) seats to carbon steel (P-Number 1) bodies of the subject valves did not fully comply with Table ND-4622.7(b)-1 of the ASME Code [Section III].
>
> The condition noted was that the base material was not preheated to 200 [degrees Fahrenheit (°F)] (minimum) as required by Table ND-4622.7(b)-1 for exemption from post weld heat treatment. The Weir welding procedure required a minimum preheat of 60°F instead of 200°F. These seat rings are attached to the valve body wall by a 3/16 or 1/4 inch fillet weld on both sides of the ring using GTAW [Gas Tungsten Arc Welding] or SMAW [Shielded Metal Arc Welding] process.

3.4 Proposed Alternative

In accordance with 10 CFR 50.55a(a)(3)(ii), the licensee proposed that the valves installed at RBS are capable of satisfactory performance without the application of elevated preheat or post-weld heat treatment and further proposed to allow the valves to remain in service for the life of each valve seat.

3.5 Licensee's Technical Basis

In its request, the licensee proposed that the immediate replacement of the valves under consideration would represent a hardship because:

a. Repairs cannot be made without draining each service water train.

b. The process of draining the service water train and making the repair will take sufficiently long so as to be prohibited by technical specifications during plant operation. Repairs must, therefore, be planned during refueling outages.

c. Due to the location of at least some of the valves, significant planning is required to conduct the operation safely, even during an outage. Due to these concerns, replacing all valves in any one outage is undesirable because it would adversely affect both trains.

d. Removal of the valves during an outage will affect the plant's ability to isolate the standby service water system from 3 of its supported systems, 1) the plant component cooling system (CCP) which supports a number of other plant systems, 2) the High Pressure Core Spray (HPCS) diesel, and 3) the Alternate Decay Heat Removal (ADHR) system used during shutdown. When the subject valves are removed, the installation of temporary barriers is required to isolate these systems from the standby service water system. This increases plant risk by $2x10^{-9}$/yr for Division I and $3x10^{-9}$/yr for Division II.

e. When the Division II standby service water is out of service, the ability to inject fire protection water into the vessel is disabled.

f. The Reactor Plant Component Cooling Water (RPCCW) system will be out of service with cooling to the spent fuel pool provided through normal service water.

g. The spent fuel pool cooling Key Safety Function risk would be coded as "YELLOW" or acceptable risk, vice "GREEN" or minimal risk for the extended period of time that standby service water trains are assumed unavailable.

h. The valves are in low dose areas; the total dose is currently estimated to be 290 mrem (milli-rem).

In its request, the licensee proposed that replacing the existing valves with valves that have received the Code-required preheat will not provide a compensating increase in the level of quality and safety when compared to the proposed alternative because:

a. Martensite is not present in the heat affected zones of the subject welds.

b. Test data indicate that the hardness and toughness of the subject welds are not substantially different from similar welds which the Code-required preheat was performed.

c. The stresses in the subject welds are sufficiently low so as to make the initiation/growth of a crack in the heat affected zones of the subject welds improbable/very slow.

d. The licensee stated in its response to request for additional information related to RBS-RR-2011-001 dated March 5, 2012 (ADAMS Accession No. ML12082A186),

any cracks which did initiate would grow in the heat affected zone and would not become through-wall cracks and would not affect the pressure boundary function of the valves.

e. Cracking in the heat affected zone could affect the leak tightness of the seat; however, none of the valves are in safety-related isolation service, so leakage of a seal weld would be of no safety consequence (see the licensee's letter dated March 5, 2012, related to RBS-RR-2011-001).

Based on these considerations, the licensee proposed that the probability of failure of one of the subject valves due to the absence of the Code-required weld preheat or post-weld heat treatment is sufficiently low so that replacement of the valves, as required by Code, will not provide a compensating level of quality or safety when compared with the licensee's proposed alternative.

3.6 NRC Staff Evaluation

As previously stated in SE Section 2.0, prior to authorizing the proposed alternative under 10 CFR 50.55a(a)(3)(ii), the NRC staff must conclude that the technical information provided in support of the proposed alternative is sufficient to demonstrate that compliance with ASME Code, Section XI, IWA-4221(c) would result in a hardship or unusual difficulty; and would not provide a compensating increase in the level of quality and safety when compared to the proposed alternative. If these criteria are met, the staff concludes that the proposed alternatives to ASME Code requirements will provide reasonable assurance of structural integrity or leak tightness of the subject components.

In considering the first condition of 10 CFR 50.55a(a)(3)(ii), the NRC staff has reviewed the information provided by the licensee in support of the licensee's contention that replacement of the valves constitutes a hardship. In that review, the NRC staff concludes that the licensee's points a through h listed in SE Section 3.5, to address the basis for hardship, to be reasonable representations of the difficulties and increases in risk which might be encountered in replacing the subject valves. The NRC staff notes that the replacement of the valves represents a significant expenditure of manpower and financial resources but concludes that these facts do not address the safe operation of the plant and, therefore, are generally not given significant consideration in the authorization of a requested alternative. The NRC staff also notes that the licensee has, both qualitatively and quantitatively, established an increase in risk associated with the replacement of the subject valves. While this risk is not large, the staff concludes that it does constitute a hardship, albeit a minor one and, therefore, satisfies the first condition of 10 CFR 50.55a(a)(3)(ii).

In considering the second condition of 10 CFR 50.55a(a)(3)(ii), whether adherence to the ASME Code requirement would provide an increase in quality and safety commensurate with the hardship or unusual difficulty imposed by meeting the code requirement, the NRC staff evaluated the technical basis and supporting documentation for the alternative as proposed by the licensee and described above in Section 3.5. The licensee's supporting documentation presented results from, and interpretations of, testing conducted on a sister valve to the subject valves. The sister valve was one of the 16 valves originally purchased by the licensee. It was

obtained by the licensee at the same time and from the same batch of valves as the subject valves. The sister valve has not been installed; rather, it has been held in the licensee's warehouse as a spare. As will become apparent below, hardenability of the valve seat to valve body fillet welds is an issue which is critical to this alternative. Based on certified materials test reports, the sister valve has a higher carbon equivalent than any of the valves in service and, therefore, the NRC staff concludes that this valve represents the bounding case as the most hardenable material. The NRC staff's evaluation of the test data provided primarily considers the following issues:

1. Presence or absence of martensite in the weld heat affected zone;

2. Hardness of the weld heat affected zone as a function of weld preheat;

3. Hardness of the weld heat affected zone as a function of the number of weld passes;

4. Automated ball indenter test results;

5. Stress levels in the vicinity of the welds; and

6. Likely fracture path should a crack occur and the effect of such a crack on the pressure boundary.

These issues are addressed in the following paragraphs:

The presence or absence of martensite is critical to the serviceability of the subject welds. Martensite is a very hard and brittle phase which can form in carbon steels upon cooling. The formation of martensite is enhanced by high carbon equivalents and high cooling rates. The presence of martensite in the heat affected zones of the subject welds would be a substantial piece of evidence that the welds would be subject to cracking and may indicate that the valves were not fit for continued service.

In the testing documentation supplied by the licensee, the licensee stated that little or no martensite is present in the weld heat affected zone of the valve tested. In support of that statement, the licensee provided several micrographs showing the microstructure of the weld heat affected zone. Based on the NRC staff's examination of these micrographs, the staff concurs with the licensee's assessment that martensite is absent from the heat affected zone of the weld tested. Based on the fact that the tested valve is from the same batch as the valves in service, the NRC staff concludes it reasonable to assume that the cooling rate of the weld in the valve tested is similar to the cooling rates in the valves in service. Additionally, based on the fact that the valve tested has a higher carbon equivalent than the valves in service, the staff concludes that the tendency of the valves in service to form martensite would be lower than that for the valve tested. By combining these two concepts, with the absence of martensite in the valve tested, the staff concludes that it is unlikely that martensite is present in the weld heat affected zones of the valves in service. While this does not confirm that these welds are suitable for continued service, it supports that contention.

As part of its testing program, the licensee conducted extensive hardness testing of the heat affected zones of the as welded components as well as additional welds made on the valve body material after the valve was sectioned for analysis. These additional welds were of the same configuration as the actual weld (i.e., fillet welds) and were made using the same seat material and weld material. All of the actual welds were made using two passes, although the position of the two passes relative to one another was not controlled. Some of the test welds were made with one pass and some were made using two passes.

Test data indicated that the maximum hardness of single-pass welds made without preheat were as much as 20 percent greater than similar welds made with preheat (approximately 500 Hv versus 400 Hv). Given that harder welds have a greater tendency to crack than softer welds (due to lower ductility), these data indicate that welds prepared without the ASME Code required preheat do not possess the same level of quality and safety as those produced using the ASME Code-required preheat. Alternatively, these data do not necessarily indicated that the subject welds do not meet the requirements of 10 CFR 50.55a(a)(3)(ii).

Test data also indicated that the number of weld passes may affect the hardness and, therefore, the cracking tendency of the welds. The use of two weld passes is expected to produce a softer weld than a single pass because the second pass is expected to temper the carbon steel heat affected zone of the first weld pass. However, unless the positioning of the second weld pass is carefully controlled, which it was not in the actual manufacture of the valves or in these tests, a large amount of scatter in the hardness data can be expected. This scatter will be due to the presence of high hardness areas in locations in which the second pass is not laid down completely over the first pass. In those areas, no tempering will occur and higher hardness will be observed.

In the data provided by the licensee, the hardness of the two-pass test weld was slightly less than the single-pass test weld. Neither of these welds were made with preheat. Additionally, the hardness of the actual valve weld, which was also a two-pass weld made without preheat, was substantially lower than the single-pass weld made without preheat. The hardness of the actual two-pass weld is approximately equal to the hardness of the additional single-pass test weld made with preheat. These data indicate that while not specifically part of the licensee's proposed alternative, two-pass welds tend to be softer and therefore less likely to crack than single-pass welds. The data also indicate that the actual weld (two passes, no preheat) has a hardness which is similar to a weld made with preheat. These data tend to support that, in this specific case, the actual welds may be suitable for continued service.

In addition to the hardness testing described above, the licensee conducted automated ball indenter tests. This test is not an American Society of Testing and Materials (ASTM) standard test, however, it provides data concerning the yield strength, ultimate tensile strength, and fracture toughness of the material tested. Of these values, fracture toughness is of the greatest interest as it is a direct indication of the material's resistance to crack propagation. These data contained a significant amount of scatter, which may be due to hard and soft spots in the weld or may be due to the position of the ball indenter relative to the weld fusion line. These data were consistent with the hardness data described above (i.e., preheat resulted in higher toughness for single-pass welds; and two-pass welds had, in general, higher toughness than single-pass welds).

In addition to the weld test data, the licensee provided an analysis of the stresses on the welds. When the valve is closed, the maximum calculated stresses in the welds were 32 percent (tensile) and 35 percent (shear) of the Code-allowable stresses. These calculations indicate that the driving forces which would initiate a crack and/or cause a crack to grow are relatively low.

In addition to the magnitude of the stresses, the licensee determined that any crack which was able to initiate and grow would grow in the heat affected zone of the weld. The NRC staff also notes that the licensee stated that "none of the valves are in safety-related isolation service, so leakage of a seal weld would be of no safety consequence." The NRC staff considers these analyses and conclusions by the licensee to be reasonable. As a result, the NRC staff concludes that it is highly unlikely that a crack, should one occur, would adversely affect the safety function of the subject valves.

Based on the data provided and the analysis above the NRC staff concludes:

1. In the general case, the provision of the Code-required preheat reduces the hardness of the weld heat affected zone significantly, indicating that a non-preheated weld does not possess the same level of safety and quality as a preheated weld.

2. In this specific case, the use two passes for each weld, the lack of untempered martensite in the heat affected zone, and the reasonably equivalent levels of hardness and toughness of the actual weld when compared with a single-pass weld with preheat, indicate that the reduction in the level of safety and quality in the subject welds due to failure to provide the Code-required preheat is not large.

3. The stress levels in the valve are reasonably low. Given these levels of stress, it is unlikely that cracks will initiate and, if they do initiate, crack growth is expected to be slow.

4. Due to the location of the heat affected zones in the welds, cracks, if initiated, are not expected to grow through wall and will not affect the safety function of the valve.

Based on the above, the NRC staff concludes that the absence of the ASME Code-required preheat causes some degradation of the quality and safety of the subject valves; however, the amount of degradation is very minor. The NRC staff, therefore, finds that replacement of the valves under consideration as required to achieve ASME Code compliance does not provide a compensating increase in the level of quality and safety when compared to the proposed alternative. The second criterion in 10 CFR 50.55a(a)(3)(ii) is, therefore, met.

Based on the above analysis, the NRC staff concludes that the technical requirements of 10 CFR 50.55a(a)(3)(ii) have been met and, therefore, that the licensee's proposal provides reasonable assurance of structural and leak tight integrity of the subject components. The NRC

staff, therefore, finds no technical basis that would preclude it from authorizing an alternative to Article IWA-4221(c), of Section XI, of the ASME Code as requested by the licensee.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the proposed alternative provides reasonable assurance of structural integrity or leak tightness of the subject components 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). Therefore, the NRC staff authorizes the proposed alternative at RBS for a period of time not to exceed the useful life of the existing valve seats.

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

Principal Contributor: David Alley

Date: January 28, 2014

The NRC staff's safety evaluation is enclosed. If you have any questions, please contact Alan Wang at 301-415-1445 or via e-mail at Alan.Wang@nrc.gov.

Sincerely,

/RA/

Douglas A. Broaddus, Chief
Plant Licensing IV-2 and Decommissioning
Transition Branch
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-458

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