April 1, 2011

MEMORANDUM TO: Kenneth G. O'Brien, Deputy Director
Division of Reactor Safety
Region III

FROM: Thomas B. Blount, Deputy Director **/RA/**
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO TASK INTERFACE AGREEMENT 2011-005, DONALD C. COOK NUCLEAR POWER PLANT REACTOR COOLANT SYSTEM PIPING CODE COMPLIANCE FOLLOWING PLASTIC DEFORMATION - MECHANICAL STRESS IMPROVEMENT

By letter dated January 20, 2011 (Agencywide Documents Access and Management System Accession No. ML110200566), the U.S. Nuclear Regulatory Commission Region III Office requested the Office of Nuclear Reactor Regulation (NRR) provide answers to the following Task Interface Agreement (TIA) questions regarding compliance with the reactor coolant system (RCS) Construction Code after application of a mechanical stress improvement process (MSIP™) which plastically deformed portions of the RCS piping.

1. Does the USAS [USA Standard] B31.1 1967 Edition Code Article 129.1 requirement, "Pipe may be bent to any radius, which will result in a bend surface free of cracks, as determined by a method of inspection specified in the design, and substantially free of buckles" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a bending process)?

2. Does the USAS B31.1 1967 Edition Code Article 129.2 requirement "Pipe may be formed (swedging, lapping, or upsetting of pipe ends, extrusion of necks, etc.), by any suitable hot or cold working method, provided such processes result in formed surfaces, which are uniform and free of cracks or other defects, as determined by a method of inspection specified in the design, and substantially free of buckles" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a forming process)?

3. Does the USAS B31.1 1967 Edition Code Article 129.3 requirement "Cold Bending and forming of carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger or ½ inch wall thickness or heavier, shall require a stress relieving treatment" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™?

The NRR staff's assessment is documented in the enclosed evaluation.

Enclosure:
As stated

CONTACT: Barry W. Miller, DPR/PLPB
(301) 415-4117

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TASK INTERFACE AGREEMENT (TIA) 2011-005
REACTOR COOLANT SYSTEM PIPING CODE COMPLIANCE FOLLOWING MECHANICAL STRESS IMPROVEMENT PROCESS™

1.0 INTRODUCTION

By letter dated January 20, 2011 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML110200566), the U.S. Nuclear Regulatory Commission (NRC) Region III Office requested the Office of Nuclear Reactor Regulation (NRR) to determine if the Donald C. Cook licensee is in compliance with the reactor coolant system (RCS) Construction Code (CC) after application of a mechanical stress improvement process (MSIP™) which plastically deformed portions of the RCS piping by providing answers to the following TIA questions:

1. Does the USAS [USA Standard] B31.1 1967 Edition Code Article 129.1 requirement, "Pipe may be bent to any radius, which will result in a bend surface free of cracks, as determined by a method of inspection specified in the design, and substantially free of buckles" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a bending process)?

2. Does the USAS B31.1 1967 Edition Code Article 129.2 requirement "Pipe may be formed (swedging, lapping, or upsetting of pipe ends, extrusion of necks, etc.), by any suitable hot or cold working method, provided such processes result in formed surfaces, which are uniform and free of cracks or other defects, as determined by a method of inspection specified in the design, and substantially free of buckles" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a forming process)?

3. Does the USAS B31.1 1967 Edition Code Article 129.3 requirement "Cold Bending and forming of carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger or ½ inch wall thickness or heavier, shall require a stress relieving treatment" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™?

2.0 BACKGROUND

During the 2010 Inservice Inspection at the Donald C. Cook Nuclear Plant, Unit 1, NRC inspectors observed MSIP™ being applied to the reactor vessel (RV) nozzle-to-pipe hot leg (HL) and cold leg (CL) dissimilar metal butt welds (DMBW) to improve the resistance of these welds to primary water stress corrosion cracking (PWSCC). The NRC inspectors identified an unresolved item related to the licensee's decision to not apply the RCS CC requirements for bending/forming to the MSIP™ process.

The RV inlet nozzles have a 27.5 inch inside diameter and contain a DMBW (Inconel 82/182), which joins the nozzle to a stainless steel safe-end, which is welded to a cast stainless steel RCS pipe elbow. The RV outlet nozzles have a 29 inch inside diameter and contain a DMBW (Inconel 82/182), which joins the nozzle to a stainless steel safe-end, which is welded to a centrifugally cast stainless steel pipe. From March 15 – 17, 2010, the licensee applied the MSIP™ process to the HL piping adjacent to the HL nozzle DMBWs and on the CL pipe elbows

adjacent to the nozzle DMBWs. The MSIP™ process applies a radial pressure to permanently reduce the inside and outside diameter of the RCS piping by approximately ½ inch. This pipe forming operation, results in a compressive residual stress at the nearby DMBWs which reduces the weld's susceptibility to PWSCC.

On March 10, 2010, NRC inspectors identified that the licensee had not considered and hence not implemented the RCS CC requirements for bending or forming pipe. The RCS piping CC was USAS B31.1 1967 Edition as identified in the Updated Final Safety Analysis Report (UFSAR) Section 4.1.6 "Codes and Standards." Article 129, "Bending and Forming," of the USAS B31.1 Code contains requirements for post bending examinations and heat treatment for stress relief. Specifically, Article 129.1 states, "Pipe may be bent to any radius which will result in a bend surface free of cracks, as determined by a method of inspection specified in the design, and substantially free of buckles." Further, Article 129.3.3 states, "Cold Bending and forming of carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger or ½ inch wall thickness or heavier, shall require a stress relieving treatment."

The NRC inspectors identified this item as unresolved item (URI) number URI 05000315/2010002-03.

Licensee Position

On March 5, 2010, American Electric Power, the licensee, completed a Title 10 of the *Code of Federal Regulations* (10 CFR) 50.59 applicability determination (2010-0062) for EC-0000048752 "MSIP for Reactor Pressure Vessel Hot and Cold Leg Nozzle Dissimilar Metal Welds." In this document, the licensee concluded that MSIP™ was a maintenance activity, which restored the applicable system, structure, or component to the as-designed condition.

The licensee has adopted its MSIP™ vendor's position as discussed in a letter dated March 19, 2010, AEP-10-49 (Rev. 1), such that the CC requirements, identified above, do not apply to the MSIP™ process. A summary of the licensee's position is provided as follows.

The applicable Code (USAS B31.1 1967 Edition) and other similar CCs for vessels and piping were reviewed by the licensee's vendor to evaluate requirements that would preclude the use of MSIP™. The conclusion reached, was that no rules exist that would categorize MSIP™ as a bending or forming process, for the Codes reviewed.

The licensee's discussion continued with a hypothetical discussion on the applicability of additional requirements if the MSIP™ process was considered forming under USAS B31.1 1967 Edition Code Article 129.2. However that discussion is outside of the scope of this TIA.

3.0 EVALUATION

Question 1: Does the USAS B31.1 1967 Edition Code Article 129.1 requirement, "Pipe may be bent to any radius, which will result in a bend surface free of cracks, as determined by a method of inspection specified in the design, and substantially free of buckles" apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a bending process)?

Response: No.

The definition of USAS B31.1 1967 Edition Code Article 129.1 indicates that bending for a pipe is “to any radius.” The MSIP™ process does not change the radius of curvature of the full pipe wall section. Therefore, the NRR staff finds that the MSIP™ process does not fall under the categorization of USAS B31.1 1967 Edition Code Article 129.1.

Question 2: Does the USAS B31.1 1967 Edition Code Article 129.2 requirement “Pipe may be formed (swedging, lapping, or upsetting of pipe ends, extrusion of necks, etc.), by any suitable hot or cold working method, provided such processes result in formed surfaces, which are uniform and free of cracks or other defects, as determined by a method of inspection specified in the design, and substantially free of buckles” apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™ (e.g., is MSIP™ a forming process)?

Response: Yes.

The definition of USAS B31.1 1967 Edition Code Article 129.2 indicates that forming can be done by any suitable cold working method. The purpose of the MSIP™ application is to re-form a pipe diameter by deflection, using hydraulic tooling, to decrease the diameter of the pipe by approximately 1 percent. This process plastically deforms the pipe in order to change the fabricated stress profile of the adjoining weld. This process is clearly cold work. Similarly, it is the intent of the process to change the stress of the adjoining weld, and as a byproduct changes the stress distribution in the pipe. As noted by the requirement to inspect for cracking under Article 129.2 and potential need for heat treatment of Article 129.3, the concern for “forming by cold work” of a pipe is the potential for cracking and increased stress magnitudes in carbon steels and ferritic alloys that could lead to the increased potential of cracking and a state of reduced fracture toughness. While the NRR staff notes that it is the intention of the MSIP™ process to change the stress distribution of the weld to promote compressive stresses on the inner half thickness of the weld, the effect of the implementation of tooling to plastically deform a pipe to a pre-set design should be evaluated as a forming process. Therefore, the NRR staff finds the MSIP™ process is a forming process under the definition of USAS B31.1 1967 Edition Code Article 129.2.

Question 3: Does the USAS B31.1 1967 Edition Code Article 129.3 requirement “Cold Bending and forming of carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger or ½ inch wall thickness or heavier, shall require a stress relieving treatment” apply to the Donald C. Cook, Unit 1, RCS piping for application of MSIP™?

Response: Yes.

If the MSIP™ process is applied to RCS piping made from carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger, or ½ inch wall thickness or heavier, then USAS B31.1 1967 Edition Code Article 129.3.3 applies. Otherwise, the requirements of USAS B31.1 1967 Edition Code Articles 129.3.4 or 129.3.5 apply to the application of MSIP™ at Donald C. Cook, Unit 1.

4.0 CONCLUSION

Based on its review of TIA 2011-005, the NRR staff finds the following:

1. The USAS B31.1 1967 Edition Code Article 129.1 requirement does not apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™.

2. The USAS B31.1 1967 Edition Code Article 129.2 requirement does apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™.

3. The USAS B31.1 1967 Edition Code Article 129.3 requirement does apply to the Donald C. Cook Unit 1 RCS piping for application of MSIP™. If the MSIP™ process is applied to RCS piping made from carbon steel having a wall thickness of ¾ inch and heavier, and all ferritic alloy pipe in nominal pipe sizes of 4 inches and larger, or ½ inch wall thickness or heavier, Article 129.3.3 is applicable. If the MSIP™ process is applied to carbon or ferritic alloy steel pipe in sizes and wall thicknesses less than those specified in Article 129.3.3, then Article 129.3.4 is applicable. Finally, If the MSIP™ process is applied to RCS piping made from all other materials, Article 129.3.5 is applicable.

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