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

January 5, 2011

Vice President, Operations
Arkansas Nuclear One
Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802

SUBJECT: ARKANSAS NUCLEAR ONE, UNIT NO. 2 - REQUEST FOR ALTERNATIVE ANO2-ISI-006 RE: IMPLEMENTATION OF A RISK-INFORMED INSERVICE INSPECTION PROGRAM BASED ON ASME CODE CASE N-716 (TAC NO. ME3128)

Dear Sir/Madam:

By letter dated January 20, 2010, as supplemented by letters dated January 28 and August 24, 2010, Entergy Operations, Inc. (Entergy, the licensee), pursuant to 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR) , submitted Request for Alternative ANO2-ISI-006. The request for relief would implement a risk-informed, safety-based inservice inspection (RIS_B) program for piping at Entergy's Arkansas Nuclear One, Unit 2 (ANO-2). The proposed program is based, in part, on the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, Code Case N-716, "Alternative Piping Classification and Examination Requirements, Section XI, Division 1." The proposed alternative is applicable to ANO-2's first period of the fourth 10-year inservice inspection (ISI) program interval which began on March 26, 2010. ANO-2 intends to start implementing the RIS_B Program during the plant's first period of the fourth 10-year ISI interval. The ASME Section XI Code of record for the fourth ISI interval at ANO-2 will be the 2001 Edition through 2003 Addenda for Examination Categories B-F, B-J, C-F-1, and C-F-2 Class 1 and 2 piping components.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request, and concludes that the proposed alternative provides an acceptable level of quality and safety. Therefore, the staff authorizes the proposed alternative in accordance with paragraph 10 CFR 50.55a(a)(3)(i) for ANO-2's fourth 10-year ISI interval. The staff's approval of the licensee's RIS_B program does not constitute approval of ASME Code Case N-716.

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 NRC staff's safety evaluation is enclosed. If you have any questions, please contact Kaly Kalyanam at (301) 415-1480 or via e-mail at kaly.kalyanam@nrc.gov.

Sincerely,

Michael T. Markley

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

Docket No. 50-368

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

RISK-INFORMED INSERVICE INSPECTION PROGRAM

REQUEST FOR ALTERNATIVE ANO2-ISI-006

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT 2

DOCKET NO. 50-368

1.0 INTRODUCTION

By letter dated January 20, 2010 (Reference 1), as supplemented by letters dated January 28, and August 24, 2010 (Reference 2 and 3), Entergy Operations, Inc. (Entergy, the licensee), requested U.S. Nuclear Regulatory Commission (NRC) authorization to implement a risk-informed inservice inspection (RI-ISI) program plan for Arkansas Nuclear One, Unit 2 (ANO-2) for the fourth 10-year inservice inspection (ISI) interval. ANO-2 proposed the use of the risk-informed, safety-based inservice inspection (RIS_B) process for the ISI of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 1 and Class 2 piping, Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds. The licensee requested implementation of this alternative during ANO-2's fourth 10-year ISI interval which began on March 26, 2010.

The licensee requests to implement a RIS_B program based, in part, on ASME Code Case N-716, "Alternative Piping Classification and Examination Requirements, Section XI, Division 1" (Code Case N-716) (Reference 4). The provisions of Code Case N-716 may be used in lieu of the requirements of IWB-2420, IWB-2430, Table IWB-2500-1 (Examination Categories B-F and B-J), IWC-2420, IWC-2430, and Table IWC-2500-1 (Examination Categories C-F-1 and C-F-2) for ISI of Class 1 or 2 piping and IWB-2200 and IWC-2200 for preservice inspection of Class 1 or 2 piping, or as additional requirements for Class 3 piping or non-Class piping, for plants issued an initial operating license prior to December 31, 2000. The Code Case N-716 requirements are expected to reduce the number of inspections required but also define additional requirements for Class 3 piping or non-Class piping.

Code Case N-716 has not been endorsed for generic use by the NRC. The licensee's relief request refers to the methodology described in Code Case N-716 instead of describing the details of the methodology in the relief request. Entergy has, however, modified the methodology described in Code Case N-716 while developing its proposed RIS_B program. When the methodology used by the licensee is accurately described in Code Case N-716, this

Enclosure

safety evaluation (SE) refers to the details found in Code Case N-716. However, when the methodology used by the licensee deviates or expands upon the methodology described in Code Case N-716, this SE refers to the licensee's submittals cited above. Therefore, Code Case N-716 is incorporated in this SE only as a source for some of the detailed methodology descriptions, as needed, and the NRC staff is not endorsing the use of Code Case N-716.

2.0 REGULATORY EVALUATION

Pursuant to paragraph 50.55a(g), "Inservice inspection requirements," of Title 10 of the *Code of Federal Regulations* (10 CFR), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, "except design and access provisions and preservice examination requirements," set forth in the Code to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations in 10 CFR 50.55a(g) also state that ISI of the ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code and applicable addenda, except where specific relief has been granted by the NRC. The objective of the ISI program, as described in Section XI of the ASME Code and applicable addenda, is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary of these components that may impact plant safety.

The regulations also require, during the first 10-year ISI interval and during subsequent intervals, that the licensee's ISI program complies with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference into 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. ANO-2 is currently in its fourth 10-year ISI interval which began on March 26, 2010. The ASME Section XI Code of record for ANO-2's fourth ISI interval is the 2001 Edition through the 2003 Addenda.

Pursuant to 10 CFR 50.55a(g), a certain percentage of ASME Code Category B-F, B-J, C-F-1, and C-F-2 pressure-retaining piping welds must receive ISI during each 10-year ISI interval. The ASME Code requires 100 percent of all B-F welds and 25 percent of all B-J welds greater than 1-inch nominal pipe size be selected for volumetric or surface examination, or both, on the basis of existing stress analyses. For Categories C-F-1 and C-F-2 piping welds, 7.5 percent of non-exempt welds are selected for volumetric or surface examination, or both. According to 10 CFR 50.55a(a)(3), the NRC may authorize alternatives to the requirements of 10 CFR 50.55a(g), if an applicant demonstrates that the proposed alternatives would provide an acceptable level of quality and safety, or that compliance with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The licensee has proposed to use a RIS_B program for ASME Code Class 1 and Class 2 piping (Examination Categories B-F, B-J, C-F-1, and C-F-2 piping welds), as an alternative to the ASME Code, Section XI requirements. As stated in Section 1.0 of this SE, the provisions of Code Case N-716 are expected to reduce the number of required examinations but may also define additional requirements for Class 3 piping or non-Class piping. The licensee's application states that this proposed program will be substituted for the current program in accordance with 10 CFR 50.55a(a)(3)(i) by alternatively providing an acceptable level of quality and safety.

In Reference 1, the licensee states that Code Case N-716 is founded in large part on the RI-ISI process as described in the Electric Power Research Institute (EPRI) Topical Report (TR)-112657, Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure" (EPRI TR) (Reference 5), which was previously reviewed and approved by the NRC. The NRC staff has reviewed the development of the proposed RIS_B and RI-ISI programs using the following documents.

1. Regulatory Guide 1.174 (RG 1.174), "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis" (Reference 6),

2. Regulatory Guide 1.178 (RG 1.178), "An Approach for Plant-Specific Risk-Informed Decisionmaking - Inservice Inspection of Piping" (Reference 7), and

3. Regulatory Guide 1.200 (RG 1.200), Revision 1, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities" (Reference 8).

RG 1.174 provides guidance on the use of probabilistic risk assessment (PRA) findings and risk insights in support of licensee requests for changes to a plant's licensing basis. RG 1.178 describes an RI-ISI program as one that incorporates risk insights that can focus inspections on more important locations while at the same time maintaining or improving public health and safety. RG 1.200 describes an acceptable approach for determining whether the quality of the PRA, in total or the parts that are used to support an application, is sufficient to provide confidence in the results, such that the PRA can be used in regulatory decision-making.

3.0 TECHNICAL EVALUATION

Code Case N-716 is based, in part, on the RI-ISI process as described in Reference 5, which was previously reviewed and approved by the NRC. In general, the licensee simplified the EPRI TR method because it does not evaluate system parts that have been generically identified as high-safety-significant (HSS), and uses plant-specific PRA to evaluate in detail only system parts that cannot be screened out as low-safety-significant (LSS).

An acceptable RI-ISI program replaces the number and locations of nondestructive examination (NDE) inspections based on ASME Code, Section XI requirements with the number and locations of these inspections based on the RI-ISI guidelines. The proposed RIS_B program permits alternatives to the requirements of IWB-2420, IWB3-2430, and IWB-2500 (Examination Categories B-F and B-J) and IWC-2420, IWC-2430, and IWC-2500 (Examination Categories C-F-1 and C-F-2), or as additional requirements for Subsection IWD, and may be used for ISI and preservice inspection of Class 1, 2, 3, or non-Class piping. All piping components, regardless of risk classification, will continue to receive ASME Code-required pressure and leak testing, as part of the current ASME Code, Section XI program.

The EPRI TR RI-ISI process includes the following steps which, when successfully applied, satisfy the guidance provided in RGs 1.174 and 1.178.

- Scope definition
- Consequence evaluation
- Degradation mechanism evaluation
- Piping segment definition
- Risk categorization
- Inspection/NDE selection
- Risk impact assessment
- Implementation monitoring and feedback

These processes result in a program consistent with the concept that, by focusing inspections on the most safety-significant welds, the number of inspections can be reduced while at the same time maintaining protection of public health and safety. In general, the methodology in Code Case N-716 replaces a detailed evaluation of the safety significance of each pipe segment with a generic population of HSS segments, followed by a screening flooding analysis to identify any plant-specific HSS segments. The screening flooding analysis is performed in accordance with the flooding PRA approach that is consistent with Section 4.5.7 of ASME RA-Sb-2005, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," Addendum B to ASME RA-S-2002 (Reference 9), as endorsed in RG 1.200.

As described below, the acceptability of the licensee's proposed RIS_B program is evaluated by comparing the processes it has applied to develop its program with the steps from the EPRI TR process.

3.1 Scope Definition

The scope of evaluation to support RIS_B program development and of the proposed changes includes ASME Code Class 1, 2, and 3, and non-Class piping welds. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP), Section 3.9.8, and a letter dated December 20, 2005, from NRC to the ASME Code Subcommittee on Nuclear Inservice Inspection (Reference 10) to address scope issues. The primary acceptance guideline in the SRP is that the selected scope needs to support the demonstration that any proposed increase in core damage frequency (CDF) and risk are small. The scope of ANO-2's evaluation included all piping where ASME inspections could be discontinued providing assurance that the change in risk estimate would, as a minimum, capture the risk increase associated with implementing the RIS_B program in lieu of the ASME program. RG 1.178 identifies different groupings of plant piping that should be included in an RI-ISI program, and also clarifies that a "full-scope" risk-informed evaluation is acceptable. The scope of the RIS_B program as defined in Code Case N-716 is consistent with the definition of full-scope expectation in RG 1.178. Therefore, the NRC staff concludes that the "full-scope" extent of the piping included in the RIS_B program changes satisfies the SRP and RG guidelines and is, therefore, acceptable.

3.2 Consequence Evaluation

The methodology described in RG 1.178 and the EPRI TR divide all piping within the scope of the proposed EPRI RI-ISI program into piping segments. The consequence of each segment failure must be estimated as a conditional core damage probability (CCDP) and conditional large early release probability (CLERP) or by using a set of tables in the EPRI TR that yield equivalent results. The consequences are used to determine the safety significance of the segments.

In contrast to the EPRI TR methodology, Code Case N-716 does not require that the consequence of each segment failure be estimated to determine the safety significance of piping segments. Instead, Code Case N-716 identifies portions of systems that should be generically classified as HSS at all plants. A consequence analysis is not required for system parts generically classified as HSS because there is no higher safety significance category to which the system part can be assigned and degradation mechanisms, not consequence, are used to select inspection locations in the HSS weld population. The licensee's PRA is subsequently used to search for any additional, plant-specific HSS segments that are not included in the generic HSS population.

Sections 2(a)(1) through 2(a)(4) in Code Case N-716 provide guidance that identifies the portions of systems that should be generically classified as HSS based on a review of almost 50 RI-ISI programs. These previous RI-ISI programs were all developed by considering both direct and indirect effects of piping pressure boundary failures and the different failure modes of piping. This is consistent with the guidelines for evaluating pipe failures with PRA described in RG 1.178, the EPRI TR, and SRP 3.9.8. Therefore, the generic results are derived from acceptable analyses. Section 2(a)(5) in Code Case N-716 provides guidance that defines additional, plant-specific HSS segments that should be identified using a plant-specific PRA of pressure boundary failures.

Each of the licensee's consequence evaluations (the generic and the plant-specific flooding analysis) considers both direct and indirect effects of piping pressure boundary failures and the different piping failure modes to systematically use risk insights and PRA results to characterize the consequences of piping failure. This is consistent with the guidelines for evaluating pipe failures with PRA described in RG 1.178 and the EPRI TR and is, therefore, acceptable.

3.3 Degradation Mechanism Evaluation

Section 3.4 of the EPRI TR, including its subsections, addresses the identification and evaluation of degradation mechanisms of interest to an RI-ISI program. This section of the EPRI TR notes that there is no correlation between design stresses and piping failures. It further notes that most piping failures are the result of active degradation mechanisms in concert with loading conditions. This section, therefore, places significant emphasis on identifying all applicable degradation mechanisms for all piping segments and appropriately addressing their significance. This section of the EPRI TR fundamentally provides a three-step process to identify and evaluate degradation mechanisms:

a) based on industry experience, identify all possible degradation mechanisms

b) based on plant operating experience, assign degradation mechanisms to piping segments

c) based on the degradation mechanisms present, assign pipe rupture potential and expected leak conditions to each pipe segment.

This section of the EPRI TR identifies, and contains a description of the conditions required for, all applicable degradation mechanisms. The section also characterizes pipe rupture potential as high, medium, or low and the expected leak conditions as large, small, or none. Although not specifically addressed in this section, these classifications are used to assign pipe failure probabilities which are used in determining the pipe failure frequency. This section of the EPRI TR requires the user to pay particular attention to the subject of water hammer during the plant operating experience review. Two reasons are cited: first, the occurrence of water hammer is highly plant-specific; and second, the presence of water hammer may necessitate changing the rupture potential category of a given pipe segment from medium to high.

The approaches employed by the EPRI TR, the Code Case N-716, and the relief request with respect to the evaluation of degradation mechanisms are generally similar. Based on the general similarity, the NRC accepts the licensee's conceptual approach to this topic. Despite the general similarity between these approaches, there are some significant differences. These are described below.

The EPRI TR and Code Case N-716 differ in the number of pipe segments which are evaluated. The EPRI TR requires the evaluation of each pipe segment to determine all applicable degradation mechanisms. This is then used to determine the safety significance of the segment. Alternatively, the Code Case identifies a generic population of piping segments to be assigned to the HSS category without evaluation, followed by a search for plant-specific HSS welds. The Code Case approach is at least as conservative as the EPRI TR approach because it identifies as HSS each piping segment which would have been so identified by the EPRI TR and because it may identify additional piping segments as being of high safety significance. Based on this conservatism, the NRC finds the use of this aspect of the Code Case acceptable.

In lieu of conducting a degradation mechanism evaluation for all the LSS piping, all locations were conservatively assigned to the medium-failure potential for the purpose of assigning a failure frequency to be used to calculate the change in risk. This results in an equal or greater estimated increase in risk from discontinued inspections because the failure frequencies would always be equal to or less than those used in the licensee's analysis if the susceptibility of all LSS welds to all degradation mechanism was determined. The NRC finds this approach acceptable because the assumed degradation mechanism will always result in the assignment of a failure probability at least as high as the complete analysis required by the EPRI TR methodology.

The EPRI TR and the Code Case both consider a long and identical list of degradation mechanisms. Both of these lists include primary water stress-corrosion cracking (PWSCC). In its relief request, the licensee considers all of these mechanisms except PWSCC. The licensee stated that PWSCC is addressed through a separate, augmented inspection program designed to specifically address welds which are susceptible to PWSCC. The basis for this program is contained in the EPRI Materials Reliability Program (MRP) 139 (Reference 11). The staff finds that the exclusion of welds susceptible to PWSCC from this RI-ISI program and inclusion of these welds in a plant's augmented inspection program designed to meet the requirements of MRP 139 is acceptable because these welds will be adequately inspected under the augmented program.

The relief request differs from the EPRI TR in the manner in which thermal stratification, cycling, and striping are addressed. The method contained in the EPRI TR does not allow for the consideration of the severity of fatigue. The method proposed by the licensee does. This method has been previously reviewed and accepted by the NRC staff by letter dated November 1, 2009, for the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (Reference 12) and will not be considered further here.

The relief request and the EPRI TR differ on the number of pipe segments evaluated for flow-accelerated corrosion (FAC) and water hammer. The EPRI TR states that all pipe segments are to be evaluated for FAC and water hammer as the presence of these degradation mechanisms may affect the failure potential for the piping segment. In its relief request, the licensee stated that it evaluated all piping segments not specified as HSS by the Code Case to determine whether FAC or water hammer was present. The licensee stated that neither FAC nor water hammer was present in the pipe segments considered. The staff concludes that this approach is acceptable as it is consistent with the EPRI TR for those segments considered and it is at least as conservative as the EPRI TR for those segments not fully evaluated as these segments were assumed to be of high-safety significance.

3.4 Piping Segment Definition

Previous guidance on RI-ISI, including RG 1.178 and the EPRI TR, centered on defining and using piping segments. RG 1.178 states, for example, that the analysis and definition of a piping segment must be consistent and technically sound.

The primary purpose of segments is to group welds so that consequence analyses can be done for the smaller number of segments instead of for each weld. Sections 2(a)(1) to 2(a)(4) in Code Case N-716 identify system parts (segments and groups of segments) that are generically assigned HSS without requiring a plant-specific consequence determination and any subdivision of these system parts is unnecessary. Section 2(a)(5) in Code Case N-716 uses a PRA to identify plant-specific piping that might be assigned HSS. A flooding PRA consistent with ASME RA-Sb-2005 searches for plant-specific HSS piping by first identifying zones that may be sensitive to flooding, and then evaluating the failure potential of piping in these zones. Lengths of piping whose failure impacts the same plant equipment within each zone are equivalent to piping segments. Therefore, piping segments are either not needed to reduce the number of consequence analyses required (for the generic HSS piping) or, when needed during the plant-specific analysis, the length of pipe included in the analysis is consistent with the definition of a segment in RG 1.178.

An additional purpose of piping segments in the EPRI TR is as an accounting/tracking tool. In the EPRI methodology, all parts of all systems within the selected scope of the RI-ISI program are placed in segments and the safety significance of each segment is developed. For each safety-significant classification, a fixed percentage of welds within all the segments of that class are selected. Additional selection guidelines ensure that this fixed percentage of inspections is distributed throughout the segments to ensure that all damage mechanisms are targeted and all piping systems continue to be inspected. Code Case N-716 generically defines a large population of welds as HSS. An additional population of welds may be added based on the risk-informed search for plant-specific HSS segments. When complete, the Code Case N-716 process yields a well-defined population of HSS welds accomplishing the same objective as accounting for each weld throughout the analysis by using segments. The Code Case provides additional guidelines to ensure that this fixed percentage is appropriately distributed throughout the population of welds subject to inspection, all damage mechanisms are targeted, and all piping systems continue to be inspected.

The NRC staff concludes that the segment identification in RG 1.178 as used as an accounting tool is not needed within the generic population of HSS welds. A flooding PRA, consistent with ASME RA-Sb-2005, utilizes lengths of piping consistent with the segment definition in RG 1.178 whenever a consequence evaluation is needed. Therefore, the proposed method accomplishes the same objective as the approved methods without requiring that segments be identified and defined for all piping within the scope of the RIS_B program.

3.5 Risk Categorization

Sections 2(a)(1) through 2(a)(4) in Code Case N-716 identify the portions of systems that should be generically classified as HSS, and Section 2(a)(5) requires a search for plant-specific HSS segments. Application of the guideline in Section 2(a)(5) in Code Case N-716 identifies plant-specific piping segments that are not assigned to the generic HSS category but that are risk-significant at a particular plant. Code Case N-716 requires that any segment with a total estimated core damage frequency (CDF) greater than 1E-6/year be assigned the HSS category. The licensee augmented this Code Case N-716 metric on CDF with the requirement to also assign the HSS category to any segment with a total estimated large early release frequency (LERF) greater than 1E-7/year. The licensee stated that these guideline values are suitably small and consistent with the decision guidelines for acceptable changes in CDF and LERF found in the EPRI TR. The licensee reviewed the results of its flooding analysis and did not identify any segments that had a CDF greater than 1E-6/year or a LERF greater than 1E-7/year.

In Reference 1, the licensee stated that these ancillary metrics were added as a defense-in-depth measure to provide a method of ensuring that any plant-specific locations that are important to safety are identified. All piping that has inspections added or removed per Code Case N-716 is required to be included in the change in risk assessment and an acceptable change in risk estimate is used to demonstrate compliance with RG 1.174 acceptance guidelines. The ancillary metrics and guidelines on CDF and LERF are only used to add HSS segments and not, for example, to remove system parts generically assigned to the HSS in Sections 2(a)(1) through 2(a)(4) of Code Case N-716.

The NRC staff agrees that a plant-specific analysis to identify plant-specific locations that are important to safety is a necessary element of RI-ISI program development. The results of the plant-specific risk categorization analysis provide confidence that the goal of inspecting the more risk-significant locations is met while permitting the use of generic HSS system parts to simplify and standardize the evaluation. Satisfying the guidelines in Section 2(a)(5) of Code Case N-716 requires confidence that the flooding PRA is capable of successfully identifying all, or most, of the significant flooding contributors to risk that are not included in the generic results. RG 1.200 states that meeting the attributes of an NRC-endorsed industry PRA standard (ASME RA-Sb-2005 at the time of the application) may be used to demonstrate that a PRA is adequate to support a risk-informed application. RG 1.200 further states that an acceptable approach that can be used to ensure technical adequacy is to perform a peer review of the PRA.

In Reference 1, the licensee states that the ANO-2 Probabilistic Safety Assessment (PSA) model underwent a peer review in 2002. Subsequent updates were performed to ANO-2's PSA model to address areas of improvement identified during the peer review. In preparation for ANO-2's transition to the National Fire Protection Association 805 Standard, a gap assessment was conducted to the PSA model. Thereafter, in May 2008, the ANO-2 Internal Events PSA model was updated to meet the RG 1.200, Revision 1 standard. A peer review was performed in July 2008. In 2009, the ANO-2 Internal Flooding Analysis was upgraded to meet the requirements of RG 1.200 Rev 1.

In Reference 3, ANO-2 performed a self-assessment utilizing the peer review findings from the ANO-1 Internal Flooding Analysis and a review of each of the supporting requirements in relation to the ASME/ANS standard. The licensee states that in some cases, the capability category for ANO-2 differed from that of ANO-1 peer review findings and these differences are due to lessons learned that were implemented during the ANO-2 analysis.

The updated ANO-2 internal flooding analysis does not allow use of screening of flood initiators when considering human actions recoveries. In Reference 3, the licensee states that the updated internal flooding analysis considers submergence, spray, jet impingement, pipe whip, temperature, and humidity effects in determining the flooding effects on equipment, thereby meeting ASME capability category III for identifying susceptibility of each safety-related structure, system, and component in a flood area to flood-induced failures. Additionally, plant-specific information was used in the determining flood initiating event frequencies. The NRC staff concludes that the use of the updated ANO-2 internal flooding PRA is acceptable for this application.

The NRC staff concludes that the CDF and LERF metrics proposed by the licensee are acceptable because they address the risk elements that form the basis for risk-informed applications (i.e., core damage and large early release). The NRC staff accepts the proposed guideline values because these ancillary guidelines are applied in addition to the change in risk acceptance guidelines in RG 1.174, and only add plant-specific HSS segments to the RIS_B program (i.e., they may not be used to reassign any generic HSS segment into the LSS category).

The NRC staff concludes that the risk categorization performed by ANO-2 provides confidence that HSS segments have been identified. Sections 2(a)(1) through 2(a)(4) in N-716 which identify generic HSS portions of systems were applied to ANO-2 piping. The licensee's PRA used to fulfill the guideline in Section 2(a)(5) was performed using a PRA of adequate technical quality based on consistency between the PRA and the applicable characteristics of the NRC-endorsed industry standard ASME RA-Sb-2005.

3.6 Inspection/NDE Selection

The licensee's submittals discuss the impact of the proposed RIS_B application on the various augmented inspection programs.

In Reference 1, the licensee states that the ANO-2 augmented inspection program for high-energy line breaks (HELB) and moderate-energy line breaks outside containment is not affected or changed by the RIS_B program. The NRC staff notes that Code Case N-716 contains no provisions for reducing the number of inspections in the inspection program for the break exclusion region. However, Code Case N-716 does include a provision to increase the number of HELB inspections if the HELB program is inspecting less than 10 percent of the welds in this region. Changes to the HELB program may be made as authorized by NRC SE, dated June 27, 2002, on EPRI TR-1006937, "Extension of the EPRI Risk Informed ISI Methodology to the Break Exclusion Region Programs" (Reference 13), or by another process found acceptable by the NRC staff.

Code Case N-716 contains no provisions for changing the FAC augmented program developed in response to NRC Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning" (Reference 14). The licensee's FAC program is relied upon to manage this damage mechanism but is not otherwise affected or changed by the RIS_B program.

MRP-139 (Reference 11) will be used as an augmented inspection program for the inspection and management of PWSCC-susceptible dissimilar metal welds and will supplement the RI-ISI program.

The ANO-2 augmented inspection programs implemented in response to NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems" (Reference 15), and NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification" (Reference 16), will be subsumed by the RIS_B program.

The ANO-2 augmented inspection program implemented in response to NRC Office of Inspection and Enforcement (IE) Bulletin 79-17, "Pipe Cracks in Stagnant Borated Water Systems at PWR Plants" (Reference 17), will be subsumed by the RIS_B program. The intergranular stress-corrosion cracking degradation mechanism addressed by this bulletin was specifically considered in the application of the RIS_B process.

The NRC staff concludes that the licensee's approach to the integration of the proposed RI-ISI program with existing augmented inspection programs acceptable because it is consistent with the EPRI TR.

Section 3.6 of the EPRI TR addresses the selection of pipe segments for inspection. This section presents the current code requirements. It also establishes requirements for the RI-ISI program related to:

- Class 1 category BJ welds
- Class 1, 2, 3 piping
- Piping subject to localized corrosion
- Impact of augmented inspection programs on the selection of pipe segments for RI-ISI
- Guidance for selecting individual welds for inspection within a group of welds
- Reinspection sample size

In its relief request, the licensee has chosen to base its selection of pipe segments on the Code Case. This Code Case is not approved for use. The Code Case has adopted a pipe selection procedure which differs from that in the EPRI TR. While the approach adopted by the Code Case may or may not be more conservative than that adopted by the EPRI TR, the change in risk evaluation required by the Code Case, and described elsewhere in this Safety Evaluation, mandates that the increase in risk (CDF and LERF), as compared to the current Code requirements, for any given system cannot exceed 1×10^{-7} and 1×10^{-8} per year and that the total increase in CDF and LERF may not exceed 1×10^{-6} and 1×10^{-7} per year. The staff concludes the approach used in the Code Case and by the licensee is acceptable because the CDF and LERF associated with the piping under consideration is generally lower, and in no case is significantly greater, than the risk currently accepted when the existing Code requirements are used.

In addition to the information regarding the number of welds to be inspected, the EPRI TR contains information concerning additional criteria to be considered when selecting welds for inspection. The EPRI TR states that licensees should consider:

- Plant-specific service history
- Predicted severity of postulated damage mechanisms
- Configuration/accessibility of element to enable effective examination
- Radiation exposure
- Stress concentration
- Physical access to element

The Code Case also contains additional information for consideration in weld selection. This list includes:

- Plant-specific cracking experience
- Weld repairs
- Random selection
- Minimization of worker exposure

Additionally, the Code Case contains requirements that inspection locations be divided among the systems under consideration and that certain percentages of inspections will be conducted concludes that this is acceptable because the information provided in the relief request is consistent with that required by the EPRI TR and the Code Case.

The NRC staff reviewed the tables provided in the relief request which address degradation mechanisms, failure potential and the number of welds selected for evaluation. The staff concludes that the data contained in these tables is consistent with the requirements of the EPRI TR.

3.7 Risk Impact Assessment

The licensee uses a change in risk estimation process approved by the NRC staff in the EPRI TR. The change in risk assessment in the EPRI TR permits the licensee to use each segment's CCDP and CLERP or, alternatively, place each segment into high-, medium-, or low-consequence "bins" and use a single bounding CCDP and CLERP for all segments in each consequence bin. Code Case N-716 also includes both alternatives, and the bounding values to be used in the bounding analysis are the same as those approved for use in the EPRI TR. The licensee uses the alternative of placing each segment into consequence bins and using the associated bounding values for all segments in each bin during the change in risk assessment.

In its submittal, the licensee identified the different types of pipe failures that cause major plant transients such as those causing loss-of-coolant accidents and corresponding types of feedwater and steam piping breaks. Conservative CCDP estimates were developed from the PRA for these initiating events. The NRC staff concludes that the scenarios described are reasonable because they are modeled in the PRA or include the appropriate equipment failure modes that cause each sequence to progress.

The licensee relied on its flooding analysis to identify the appropriate consequence bin for welds whose failure does not cause a major plant transient and for which a consequence estimate is required. As discussed above, the licensee performed its flooding analysis consistent with ASME RA-Sb-2005. The licensee stated that its flooding analysis did not identify any high-consequence segments (lower-bound CCDP and CLERP of 1E-4 and 1E-5, respectively) for LSS Class 2 piping that was being inspected under the ASME ISI program. Only segments with locations at which an inspection is being discontinued need to be included in the change in risk calculation so limiting the consequence evaluation to segments that are inspected is acceptable.

Section 5 in Code Case N-716 requires that any piping that has NDE inspections[1] added or removed per Code Case N-716 be included in the change in risk assessment. The licensee used nominally the upper-bound estimates for CCDP and CLERP. Acceptance criteria provided in Section 5(d) in Code Case N-716 include limits of 1E-7/year and 1E-8/year for increase in CDF and LERF for each system, and limits of 1E-6/year and 1E-7/year for the total increase in CDF and LERF associated with replacing the ASME Code, Section XI program with the RIS_B

[1] Code Case N-716 requires no estimated risk increase for discontinuing surface examinations at locations that are not susceptible to outside diameter attack (e.g., external chloride stress-corrosion cracking]. The NRC staff concluded during the review and approval of the EPRI TR that the surface exams do not appreciably contribute to safety and need not be included in the change in risk quantification and, therefore, exclusion of surface examinations from the change in risk evaluations is acceptable.

program. These guidelines and guideline values are consistent with those approved by the NRC staff in the EPRI TR and are, therefore, acceptable.

The change in risk evaluation approved in the EPRI TR method is a final screening to ensure that a licensee replacing the ASME Code, Section XI program with the risk-informed alternative evaluates the potential change in risk resulting from that change and implements it only upon determining with reasonable confidence that any increase in risk is small and acceptable. The licensee's method is consistent with the approved EPRI TR method with the exception that the change in risk calculation in Code Case N-716 includes the risk increase from discontinued inspection in LSS locations. CCDP and CLERP values greater than 1E-4 and 1E-5 were used for LSS welds to bound plant internal flooding study results. These values used for CCDP and CLERP were determined based on results from the plant internal flooding study and are conservatively applied as an upper bound for all LSS welds. In lieu of conducting a formal degradation mechanism evaluation for all LSS piping (e.g., thermal fatigue), these locations were conservatively assigned to the medium-failure potential category for use in the change in risk assessment. The high-failure potential category is not applicable since a review was conducted to ascertain LSS piping is not susceptible to FAC or water hammer. The NRC staff concludes that the licensee's method described in the submittal is acceptable because the deviation from the approved EPRI TR method expands the scope of the calculated change in risk.

Using the upper-bound CCDP/CLERP will overestimate the risk increase at locations when inspections are discontinued, but will also overestimate the risk decrease at locations where inspections are added. In Reference 3, the licensee reported a sensitivity study where the risk impact is estimated using upper-bound values for CCDP and CLERP in those cases that result in a risk increase and lower-bound values for CCDP and CLERP in those cases that result in a risk decrease. The licensee reported that the delta risk impact guidelines are not exceeded in the bounding study.

The licensee provided the results of the change in risk calculations in the submittals and noted that most of the results indicate a decrease in risk and that all the estimates satisfy both the system level and the total guidelines. Therefore, the NRC staff concludes that any increase in risk is small and acceptable.

3.8 Implementation Monitoring and Feedback

Section 6.2.3 of the EPRI TR addresses implementation, performance monitoring, and corrective action strategies. This section does not contain sufficient information to be useful as an evaluation tool. However, this section states that there are no unique aspects of the EPRI method that would suggest a need to depart from any of the requirements of Element 3 of RG 1.178. Element 3 of RG 1.178 will, therefore, be used to evaluate this aspect of the request.

Element 3 of RG 1.178 is divided into three categories: program implementation, performance monitoring, and corrective actions. The program implementation category requires that a licensee's RI-ISI program have a schedule for inspecting all piping segments categorized as safety significant. It further states that the inspection interval will normally be that prescribed by Section XI of the ASME Code but that certain degradation mechanisms may require the interval to be altered. The performance monitoring category requires that a licensee's RI-ISI program be updated based on changes in plant design features, changes in plant procedures, equipment performance changes, examination results, and plant or industry operating experience.

Additionally, a licensee must update its program periodically to correspond to the requirements contained in Section XI of the ASME Code, Inspection Program B. The corrective action category requires a corrective action program that is consistent with the requirements of Section XI of the ASME Code for both Code class and non-Code class piping.

The licensee's information concerning this topic was obtained from the relief request itself and from Sections 6 and 7 of the Code Case. The Code Case information was used by the NRC in this review based on the licensee's statement that it would develop implementation procedures for its program in accordance with the Code Case. In its relief request, the licensee stated that it has a corrective action program and that it will review the RI-ISI program periodically as required by the ASME Code or more frequently as directed by the NRC, or industry or plant-specific feedback. The inspection frequency and program updates are addressed in Sections 6 and 7 of the Code Case. These sections indicate that inspection frequencies should normally be in accordance with ASME Code requirements and that updates should be made on a Code-dictated schedule, or more frequently in response to plant and industry events or information.

The NRC concludes that the licensee's approach to implementing the program to be acceptable because, in accordance with RG 1.178, the licensee indicated that it inspects components on a frequency based on the ASME Code, that it has a corrective action program, and that it updates the program periodically and in response to plant and industry events and information.

3.9 Examination Methods

Section 4 of the EPRI TR addresses the NDE techniques which must be used in an RI-ISI program. This section emphasizes the concept that the inspection technique utilized must be specific to the degradation mechanism expected. Table 4.1 of the EPRI TR summarizes the degradation mechanisms expected and the examination methods which are appropriate. Specific references are provided to the ASME Code concerning the manner in which the examination is conducted and the acceptance standard.

Code Case N-716 addresses the issue of degradation mechanism/inspection technique in Table 1, "Examination Categories." Like Table 4.1 of the EPRI TR, Table 1 lists the degradation mechanism and corresponding inspection techniques. This table also provides references to the ASME Code concerning the manner in which the examination is conducted and the acceptance standard.

In its relief request, the licensee states that the implementation of the RI-ISI program will conform to the Code Case (i.e., each HSS piping segment will be assigned to the appropriate item number within Table 1 of the Code Case). The NRC staff concludes this is acceptable because proper assignment of piping segments into Table 1 will ensure that appropriate inspections to detect the degradation mechanism under consideration are conducted. The NRC concludes this approach is acceptable because it is consistent with the EPRI TR.

4.0 REGULATORY COMMITMENTS

In Reference 1, as supplemented by References 2 and 3, the licensee made the following regulatory commitments:

Commitment	One-time Action	Scheduled Completion Date
ANO-2 is in the process of evaluating MRP-146, *Materials Reliability Program: Management of Thermal Fatigue in Normally Stagnant Non-Isolable Reactor Coolant System Branch Lines*, and these results will be incorporated into the RIS_B Program, as warranted	X	June 30, 2011
The request for alternative pertaining to the use of Code Case N-578 will be withdrawn for use at ANO-2 upon NRC approval of the RIS_B Program submittal.	X	Upon NRC approval of this request for alternative
Upon approval of the RIS_B Program, procedures that comply with the guidelines described in EPRI TR-112657 will be prepared to implement and monitor the program.	X	Upon NRC approval of this request for alternative

The NRC staff concludes 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).

5.0 CONCLUSION

Pursuant to 10 CFR 50.55a(a)(3)(i), alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC, if the licensee demonstrates that the proposed alternatives will provide an acceptable level of quality and safety. In this case, the licensee proposed to use an alternative to the risk-informed process described in Code Case N-716 which is based, in large part, on NRC-approved EPRI TR-112657. The implementation strategy is consistent with the EPRI TR guidelines because the number and location of inspections is a product of a systematic application of the risk-informed process. Other aspects of the licensee's ISI program, such as system pressure tests and visual examination of piping structural elements, will continue to be performed on all Class 1, 2, and 3 systems in accordance with ASME Code, Section XI. This provides a measure of continued monitoring of areas that are being eliminated from the NDE portion of the ISI program. As required by the EPRI TR methodology, the existing ASME Code performance measurement strategies will remain in place. In addition, the Code Case N-716 methodology provides for increased inspection volumes for those locations that are included in the NDE portion of the program.

The EPRI RI-ISI methodology contains details for developing an acceptable RI-ISI program. Code Case N-716, modified as described by the licensee in its submittals, describes a methodology similar to the EPRI methodology but with several differences as described above in this SE. The NRC staff has evaluated each of the differences and concludes that the licensee's proposed methodology, when applied as described, meets the intent of all the steps endorsed in the EPRI TR, is consistent with the guidance provided in RG 1.178, and satisfies the guidelines established in RG 1.174.

The NRC staff concludes that the licensee's proposed RIS_B program will provide an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3)(i) for the proposed alternative to the piping ISI requirements with regard to (1) the number of locations, (2) the locations of inspections, and (3) the methods of inspection. Therefore, the proposed RI-ISI program is authorized for ANO-2 for the first period of the fourth 10-year ISI interval pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that this alternative will provide an acceptable level of quality and safety.

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.

6.0 REFERENCES

1. Bice, D. B., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Request for Alternative – Implementation of a Risk-Informed Inservice Inspection Program Based on ASME Code Case N-716," dated January 20, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100210161).

2. Bice, D. B., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information, Request for Alternative – Implementation of a Risk-Informed Inservice Inspection Program Based on ASME Code Case N-716," dated January 28, 2010 (ADAMS Accession No. ML100280753).

3. Giles, M.A., Entergy Operations, Inc., letter to U.S. Nuclear Regulatory Commission, "Response to Request for Additional Information, Request for Alternative – Implementation of a Risk-Informed Inservice Inspection Program Based on ASME Code Case N-716," dated August 24, 2010 (ADAMS Accession No. ML102380446).

4. ASME Code Case N-716, "Alternative Piping Classification and Examination Requirements, Section XI, Division 1," American Society of Mechanical Engineers, New York, New York, April 19, 2006.

5. Electric Power Research Institute, Topical Report (TR)-112657 Revision B-A, "Revised Risk-Informed Inservice Inspection Evaluation Procedure (PWRMRP-05)," December 1999 (ADAMS Accession No. ML013470102).

6. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.174, Revision 1, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-

Specific Changes to the Licensing Basis," November 2002 (ADAMS Accession No. ML023240437).

7. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.178, Revision 1, "An Approach for Plant-Specific Risk-Informed Decisionmaking - Inservice Inspection of Piping," September 2003 (ADAMS Accession No. ML032510128).

8. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.200, Revision 1, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," January 2007 (ADAMS Accession No. ML070240001).

9. ASME RA-Sb-2005, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," Addendum B to ASME RA-S-2002, ASME, New York, New York, December 30, 2005.

10. Dyer, J. E., U.S. Nuclear Regulatory Commission, letter to G.C. Park, ASME Code Subcommittee on Nuclear Inservice Inspection, related to codification of inspection requirements of reactor coolant system dissimilar metal welds at pressurized-water reactors, dated December 20, 2005 (ADAMS Accession No. ML053480359).

11. Materials Reliability Program: Primary System Piping Butt Weld Inspection and Evaluation Guideline (MRP-139), Revision 1, December 2008, Electric Power Research Institute, Palo Alto, California.

12. Salgado, N. L., U.S. Nuclear Regulatory Commission, letter to J. A. Spina, Calvert Cliffs Nuclear Power Plant, LLC, "Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 – Relief Requests for the Fourth 10-Year Interval Inservice Inspection Program (TAC Nos. ME0293, ME0294, ME0295, ME0296, ME0298, ME0299, ME0301, and ME0302)," dated November 19, 2009 (ADAMS Accession No. ML093220090).

13. Holden, C., U.S. Nuclear Regulatory Commission, letter to G. L. Vine, Electric Power Research Institute, and safety evaluation on EPRI Topical Report (TR)-1006937, "Extension of the EPRI Risk Informed ISI Methodology to the Break Exclusion Region Programs," dated June 27, 2002 (ADAMS Accession No. ML021790518).

14. U.S. Nuclear Regulatory Commission, Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning," dated May 2, 1989 (ADAMS Legacy Library Accession No. 8905040276).

15. U.S. Nuclear Regulatory Commission, NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems," dated June 22, 1988 (ADAMS Legacy Library Accession No. 8806170291).

16. U.S. Nuclear Regulatory Commission, NRC Bulletin 88-11, "Pressurizer Surge Line Thermal Stratification," dated December 20, 1988 (ADAMS Legacy Library Accession No. 8812150158).

17. U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement (IE) Bulletin 79-17, "Pipe Cracks in Stagnant Borated Water Systems at PWR Plants," dated October 29, 1979 (ADAMS Accession No. ML031220102).

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Date: January 5, 2011

The NRC staff's safety evaluation is enclosed. If you have any questions, please contact Kaly Kalyanam at (301) 415-1480 or via e-mail at kaly.kalyanam@nrc.gov.

Sincerely,

/RA/

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

Docket No. 50-368

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Safety Evaluation

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