April 9, 2004

Mr. L. William Pearce
Vice President
FirstEnergy Nuclear Operating Company
Beaver Valley Power Station
Post Office Box 4
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2 (BVPS-1 AND 2) - RISK-INFORMED INSERVICE INSPECTION (RI-ISI) PROGRAM (TAC NOS. MB5687 AND MB5688)

Dear Mr. Pearce:

By letter dated July 24, 2002, FirstEnergy Nuclear Operating Company (FENOC or licensee), requested approval of an alternative RI-ISI program for the BVPS-1 and 2 ISI of American Society for Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code), Class 1 and 2, piping welds. The letter included an enclosure describing the proposed program. Additional clarifying information was provided in FENOC's letters dated February 18, May 14, August 22, October 28, and December 19, 2003, and February 20, 2004.

The proposed RI-ISI program, developed in accordance with Westinghouse Owners Group Topical Report WCAP-14572, Revision 1-NP-A, is an alternative to the current ASME Code, Section XI, ISI Program and is applicable to Class 1 and 2 piping at BVPS-1 and 2. The licensee deviated from the approved methodology for estimating the segment failure frequency for piping segments that include piping of different diameters. The licensee reevaluated these segments and modified the proposed RI-ISI program so that the final proposed program is the same as would have been developed if the approved methodology had been used. The results of our review indicate that the licensee's proposed RI-ISI program is consistent with WCAP-14572, Revision 1-NP-A, and is an acceptable alternative to the requirements of the ASME Code, Section XI, for ISI of ASME Code, Class 1 and 2 piping, Categories B-F, B-J, C-F-1, and C-F-2 welds.

Therefore, FENOC's request for relief is authorized for the third 10-year ISI interval for BVPS-1 and the second 10-year ISI interval for BVPS-2 pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a (10 CFR 50.55a(a)(3)(i)) on the basis that the proposed alternative provides an acceptable level of quality and safety. This authorization does not constitute Nuclear Regulatory Commission (NRC) approval of the licensee's method to estimate the failure frequency of segments that include piping of different diameters. RI-ISI programs are living programs requiring feedback of new relevant information to ensure the appropriate identification of high safety-significant piping locations. Any RI-ISI program that uses the results of calculations based on an unapproved method to review or adjust the safety significance of piping locations will require prior NRC review and approval of a request for relief pursuant to 10 CFR 50.55a(a)(3)(i). The details of the NRC staff's review are contained in the enclosed safety evaluation.

If you have any questions, please contact your NRC Project Manager, Mr. Timothy G. Colburn at 301-415-1402.

Sincerely,

/RA by PTam for/

Richard J. Laufer, Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-334 and 50-412

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RISK-INFORMED INSERVICE INSPECTION (RI-ISI) PROGRAM

FIRSTENERGY NUCLEAR OPERATING COMPANY

BEAVER VALLEY POWER STATION, UNIT NOS. 1 AND 2

DOCKET NOS. 50-334 AND 50-412

1.0 INTRODUCTION

Current inservice inspection (ISI) requirements for Beaver Valley Power Station, Unit Nos. 1 and 2 (BVPS-1 and 2), are contained in the American Society of Mechanical Engineers (ASME), *Boiler and Pressure Vessel Code*, 1989 edition, Section XI, Division 1, *Rules for Inservice Inspection of Nuclear Power Plant Components* (hereinafter called the Code). In a submittal dated July 24, 2002, the licensee, FirstEnergy Nuclear Operating Company (FENOC), proposed a new program entitled *Risk-Informed Inservice Inspection Program Plans ISI (Inservice Inspection) Program Relief Request* (Reference 1). The submittal included two attachments describing the RI-ISI program development and results, one for BVPS-1 and one for BVPS-2. The structure and content of the two attachments are very similar and, unless otherwise noted, evaluations and references in this safety evaluation refer to both attachments. Additional clarifying information was provided by letters dated February 18, 2003 (Reference 2), May 14, 2003 (Reference 3), August 22, 2003 (Reference 4), October 28, 2003 (Reference 5), December 19, 2003 (Reference 6), and February 20, 2004 (Reference 7). The licensee's RI-ISI program was developed in accordance with the Westinghouse Owners Group (WOG) Topical Report WCAP-14572, Revision 1-NP-A (WCAP) (Reference 8), which was previously reviewed and approved by the Nuclear Regulatory Commission (NRC) staff.

2.0 BACKGROUND

2.1 Applicable Requirements

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a (10 CFR 50.55a(g)), requires that ISI of the ASME Code, Class 1, 2, and 3 components be performed in accordance with Section XI of the ASME Code and applicable addenda, except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) states, in part, that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the applicant demonstrates that the proposed alternatives would provide an acceptable level of quality and safety or if the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

ENCLOSURE

The regulations require that ISI of components conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of the Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

2.2 Summary of Proposed Approach

In the licensee's proposed RI-ISI program, piping failure potential estimates were determined using a windows operating system version of the software program contained in Supplement 1 to Reference 8, entitled "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," that utilizes probabilistic fracture mechanics technology, industry piping failure history, plant-specific piping failure history, and other relevant information. Using the failure potential and supporting insights on piping failure consequences from the licensee's probabilistic risk assessment (PRA), safety significance ranking of piping segments was established to determine inspection locations. The RI-ISI program maintains the fundamental requirements of the Code, such as the examination technique, frequency, and acceptance criteria. However, the RI-ISI program is intended to reduce the number of required examination locations significantly while maintaining an acceptable level of quality and safety.

The licensee plans to implement the RI-ISI program during the second period of the third ASME Code inspection interval at BVPS-1. The licensee will inspect 66 percent of the required RI-ISI program examinations. For BVPS-2 the licensee plans to implement the RI-ISI program during the second period of the second ASME Code inspection interval. The licensee will inspect 66 percent of the required RI-ISI program examinations. Other non-related portions of the Code requirements, as well as the ongoing augmented inspection programs at BVPS-1 and 2, will remain unchanged. The RI-ISI program follows a previously approved methodology delineated in Reference 8.

3.0 EVALUATION

Pursuant to 10 CFR 50.55a(a)(3), the NRC staff has reviewed and evaluated the licensee's proposed RI-ISI program, including those portions related to the applicable methodology and processes contained in Reference 8, based on guidance and acceptance criteria provided in Regulatory Guides (RGs) 1.174 (Reference 9) and 1.178 (Reference 10) and in NUREG-0800, Standard Review Plan (SRP), Chapter 3.9.8 (Reference 11). The licensee identified three deviations from the approved methodology and the NRC staff identified an additional deviation. Inclusion of the parameter uncertainty in the initial calculation of the RRW values, crediting of leak detection for several non-RCS piping segments, and determination of sample size in three segments (in BVPS-1) without application of the statistical method were identified by the licensee and found acceptable by the NRC staff as discussed in Section 3.2. The fourth deviation, whereby the failure frequency for segments made up of multiple pipe sizes is developed by combining limiting inputs for each different sized sub-segment and not for the entire segment, is not endorsed by the NRC staff as a generally acceptable modification of the WCAP methodology.

3.1 Proposed Changes to the ISI Program

The scope of the licensee's proposed RI-ISI program is limited to ASME Code, Class 1 and Class 2 piping only, consisting of Category B-F and B-J welds, and Class 2 piping, Categories C-F-1 and C-F-2 welds. The RI-ISI program was proposed as an alternative to the existing ISI program that is based on the requirements of the Code. A general description of the proposed changes to the ISI program was provided in Sections 3 and 5 of the licensee's submittal (Reference 1). In Table 5-1 for BVPS-1 and 2 of Reference 1, a comparison of inspection location selection between the current ISI program and the proposed RI-ISI program is provided. The discussions and Tables in Reference 1 do not reflect: (1) 15 high safety-significant (HSS) segments that the expert panel had reduced to low safety-significant (LSS) in Reference 1, but which the panel reclassified to HSS in Reference 4; (2) 2 additional non-destructive examinations (NDE) added to these HSS segments; nor, (3) one extra NDE added in Reference 5 to address the licensee's use of multiple pipe size segments. These modifications to the RI-ISI programs are, however, adequately described in the referenced documents and Reference 1 need not be changed. The NRC staff finds that the information submitted adequately defines the proposed changes resulting from the RI-ISI program.

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178 (References 9 and 10), the licensee provided the results of an engineering analysis of the proposed changes, using a combination of traditional engineering analysis and PRA. The licensee stated that the reactor coolant piping (RCP) will continue to receive system pressure test and VT-2 examinations and the larger RCP segments were retained in the RI-ISI program for defense-in-depth considerations. Demonstration that the proposed changes are consistent with the principle of defense-in-depth is also accomplished by evaluating a location's susceptibility to each potential degradation mechanism that may be a precursor to leak or rupture and then performing an independent assessment of the consequence of a failure at that location. No changes to the evaluation of design-basis accidents in the final safety analysis report are being made by the RI-ISI process. Therefore, sufficient safety margins will be maintained.

The licensee stated that the applicable aspects of the ASME Code not affected by the proposed alternative RI-ISI program and the ongoing augmented inspection programs will be retained. This is consistent with the approved WCAP-14572, Revision 1-NP-A; therefore, it is acceptable.

WCAP-14572, Revision 1-NP-A states, in part, that the SRRA computer models are to be used where applicable to estimate the failure probabilities of the structural elements in each of the piping segments. In Reference 1, the licensee stated that the failure probabilities for BVPS-1 and 2 piping segments were all derived using the WinSRRA software program where the SRRA program was applicable. All structural element configurations in BVPS-1 could be adequately modeled using the computer program. Three segments in BVPS-2 contained pressure fit components and could not be modeled with the SRRA computer program. The failure frequency for these structural elements was based on industry history for failure of this type of fitting. The WCAP provides for the use of industry failure data when the SRRA code can not model the structural element configuration. The NRC staff finds the methodology used to estimate the failure frequency of structural elements comports with the WCAP, and is, therefore, acceptable.

The licensee stated in Reference 1 that an engineering team was established having expertise in the following areas: ISI, NDE, materials, stress analysis, and system engineering. The engineering team was trained in the failure probability assessment methodology and the Westinghouse SRRA code, including the identification of the software capabilities and limitations as described in WCAP-14572, Revision 1-NP-A. The licensee also stated that the effects of ISI of existing augmented programs were included in the risk evaluations and were used in categorizing the segments as described in the approved WCAP-14572, Revision 1-NP-A.

The licensee reported two deviations from the WCAP-14572, Revision 1-NP-A, methodology for both units, one regarding the evaluation of the potential impact of parameter uncertainty and the other the credit taken for leak detection when calculating pipe failure probabilities. A third deviation was reported for BVPS-1 regarding the use of the statistical calculation to determine the number of locations to inspect in several segments. The WCAP states that an initial calculation of the risk reduction worth (RRW) using point estimate input values should be followed by a sensitivity study that assigns uncertainty to the input values. The aim of the sensitivity analysis is to investigate the potential movement of segments from low to high safety significance based on the uncertainty of quantitative inputs and the guideline values defining the low, medium and high RRW ranges. Instead of performing an uncertainty analysis as a sensitivity study, the licensee incorporated the uncertainty analysis directly into the initial calculation of the RRW values. This process also identifies the segments that might move to higher safety-significance based on the uncertainty in the inputs, and is, therefore, acceptable.

WCAP-14572, Revision 1-NP-A, allows credit for detecting (and isolating, repairing, or otherwise terminating a potential accident sequence) a leak in the reactor coolant system (RCS) piping before it develops into a pipe break for piping inside of containment. This credit reflects the highly developed leak detection systems used to monitor leakage from the RCP. Detection of a leak before break is plausible for any non-RCS segment located inside the containment that interfaces with the RCS by use of radiation and sump level monitors that can detect a leak in the segment as reliably as that of an RCS leak. The licensee identified two non-RCS segments inside the containment and credited leak detection for these segments. Since the segments are subject to essentially the same leak-detection capabilities as that of an RCS leak, the extension of credit for leak detection in these segments is reasonable and acceptable.

In Unit 1, the licensee identified two segments where the selection of the number of locations for inspection deviated from the WCAP. The licensee determined that special circumstances unforeseen in the WCAP resulted in the statistical method not being applicable even though the characteristics of the segments and associated elements were within the parameters of applicability defined in the WCAP. These segments are composed of thin-walled piping and had no construction Code radiograph of the welds for final acceptance. The subject piping did receive surface examination on each weld of the two segments. Since the subject piping did not receive a pre-service volumetric examination on each weld, the existence of a flaw was assumed for SRRA calculations used in the risk evaluation and the Perdue model. The licensee stated that the criterion for use of the statistical method with the existence of an (assumed) unacceptable flaw determined in accordance with the ASME Code, Section XI, defeats the use of the statistical method for determining the number of examination locations for these thin-walled piping segments. The NRC staff has taken into consideration the material type, the fracture toughness, pressure/temperature rating, results of previous inservice examinations, and existing degradation mechanisms to evaluate the licensee's examination locations. The NRC staff accepts the licensee's rationale in regard to the criteria for selecting the number of examination locations for these two segments in lieu of the Perdue model.

The licensee reported no other deviations from WCAP-14572, Revision 1-NP-A; however, in response to an NRC staff question, a fourth deviation from the WCAP methodology was identified. The failure frequency calculated by the SRRA computer code is calculated for an individual structural element, i.e., a specific weld geometry, material properties, and environmental conditions. The WCAP methodology develops and uses a single-failure frequency estimate to characterize each pipe segment's likelihood of failure regardless of the number of welds within the segment. The NRC staff's approval of the use of a single segment-failure frequency independent of the number of welds was based on Westinghouse's proposal that the failure frequencies obtained from the SRRA code are calculated by inputting the conditions (typically the most limited or bounding) for the entire piping segment. Essentially, the piping failure probability is a representation or characterization of the material properties and environment in the piping segment.

In Reference 2, the licensee stated that some segments included piping of multiple pipe sizes. The licensee created sub-segments based on pipe size to facilitate estimating the failure frequency using the SRRA code. Failure frequency estimates for segments made up of multiple pipe sizes were determined by performing multiple SRRA cases, one SRRA case for each sub-segment. The most limiting inputs, based on the expected degradation mechanism(s) for the individual sub-segment, were developed for each SRRA case in accordance with the guidance in the WCAP. The highest sub-segment failure probability was used to represent the segment failure probability for risk ranking and change in risk purposes. The licensee's proposed method only combines limiting inputs for each sub-segment and not for the entire segment, and is, therefore, a deviation from the approved methodology.

The WCAP methodology allows, but does not require, multiple sized piping within a segment. Although emphasis is placed on defining piping segments as lengths of piping that have the same consequences caused by pipe failure, pipe size is one of the four criteria that can be used to define segments. An additional criterion is that the estimated failure probability should not be excessively conservative. The NRC staff has determined that there are two alternative methods to incorporate multiple pipe-size segments into the analysis that comport with the approved methodology. One method would involve combining the most limiting inputs in the entire segment into a single weld and using the estimated failure frequency of that weld to represent the segment. The other method would be to divide the segment into new segments, each with similar or the same size. If the estimated failure frequency developed by combining the most limiting inputs in the entire segment into a single weld is excessively conservative, the pipe segment should be divided into new segments to comport with the approved methodology. In References 5 and 6, the licensee reported the results of an evaluation of the difference in the number and locations of inspections between the methodology used by the licensee as compared to the approved methodology described above.

The licensee reported that BVPS-1 had 29 HSS segments that included piping with multiple pipe sizes. The results of the evaluation indicated that 16 segments with multiple pipe sizes fully comported with the requirements for estimating a segment frequency, e.g., that the highest sub-segment analysis was identical to combining all the most limiting inputs in the entire segment. For 11 of the remaining segments, the failure frequency estimate obtained by combining all the most limiting conditions was essentially the same as the estimate for the highest sub-segment, and, therefore, not excessively conservative. One segment included both socket and butt welds and because of this configuration would have the same locations inspected if the segment was divided into new segments. One segment had to be divided into two new segments and one inspection location was added.

The licensee reported that BVPS-2 had 32 HSS segments that included piping of different diameters. The results of the evaluation indicated that 23 segments with multiple pipe sizes fully comported with the requirements for estimating a segment frequency, e.g., that the highest sub-segment analysis was identical to combining all the most limiting inputs in the entire segment. For four of the remaining segments, the failure frequency estimate obtained by combining all the most limiting conditions was essentially the same as the estimate for the highest sub-segment, and, therefore, not excessively conservative. Five segments included both socket and butt welds, and because of this configuration would have the same locations inspected if the segments were divided into new segments.

The licensee identified each LSS segment containing multiple pipe sizes which also had been inspected in accordance with the ASME Code, Section XI. The licensee determined that none of these segments had been inspected on more than one pipe size and concluded that there would be no additional examination required if the segments were separated into new segments based on pipe size. The WCAP methodology estimates an increase in risk only when ASME Code, Section XI, inspections are discontinued in a segment. The licensee's method identified the highest sub-segment's frequency and used that frequency when calculating the increase in risk associated with discontinued inspections in the LSS segments. New segments created by separating a segment based on pipe size that had not been inspected in accordance with the ASME Code would not contribute to the increase in risk estimates. Additional inspections would only be required if the estimated increase in risk exceeded the WCAP guidelines. Therefore, the estimated increase in risk would not change or would decrease if the LSS segments were separated based on pipe size because no more than one of the new segments would contribute to the increase in risk, and the failure frequency for that segment would be equal to or less than the frequency assigned to the original multiple pipe-sized segment. The NRC staff concurs with the licensee's conclusion that additional inspections would not be required if the LSS segments were separated based on pipe size.

The licensee compared the number and location of ISI inspections developed using their methodology to the number and location of ISI inspections that would have been developed using the approved methodology. The licensee stated (Reference 5) that one additional inspection at BVPS-1 would have been required if they had used the approved methodology, and committed to add that inspection location to the RI-ISI program (Reference 6). The NRC staff finds the proposed RI-ISI programs at BVPS-1 and 2 acceptable because they are consistent with the approved methodology. However, this acceptance does not constitute NRC staff endorsement of the licensee's method as a generally acceptable modification of the WCAP methodology.

3.3 Probabilistic Risk Assessment

The licensee used Version BV1REV2 dated June 30, 1998 and Version BV2REV2 dated October 31, 1997, of the PRAs to evaluate the impacts on plant risk for BVPS-1 and BVPS-2, respectively. The estimated CDF and LERF for BVPS-1 are 8.52E-5 per year and 9.23E-7 per year, respectively. The estimated CDF and LERF for BVPS-2 are 7.14E-5 per year and

1.22E-6 per year, respectively. The individual plant examination (IPE) model for Unit 1 was submitted on October 1, 1992, and the NRC staff's evaluation report dated September 30, 1996, included the finding that the IPE met the intent of GL 88-20. The IPE model for Unit 2 was submitted on March 17, 1993, and the NRC staff's evaluation report dated May 13, 1992, included the finding that the IPE met the intent of GL 88-20. The NRC staff's review of the IPEs noted that the identification of the potential contribution of pre-initiator human errors to system unavailability could be strengthened. The licensee reported that plant-specific data on operating system unavailability (including pre-initiator human errors) collected for the maintenance rule has been incorporated in the PRA. Unavailability caused by pre-initiator human errors for standby systems has been estimated based on human error rates and test frequencies. These improvements were incorporated into the models used to support the RI-ISI submittal (Reference 2).

The WOG peer review of the PRA was conducted during the week of July 15-19, 2002. The review was conducted on the BVPS-2 PRA Version BV2REV3 in detail. The BVPS-1 PRA Version BV1REV2 was reviewed through a comparison with the Unit 2 model (Reference 2). The results of these reviews could not be incorporated into the PRA models to support the July 24, 2002, RI-ISI submittal. In Reference 7, the licensee stated that incorporation of the resolution of the *Facts and Observation* from the WOG peer review is not expected to have a significant impact on the proposed RI-ISI program. In addition, Reference 1 states that the RI-ISI program is a living program and, at a minimum, risk ranking of piping segments will be reviewed and adjusted on an ASME Code period basis. The NRC staff finds the use of the June 30, 1998, Version BV1REV2 and the October 31, 1997, Version BV2REV2 of the PRAs acceptable because the weakness identified in the IPEs had been addressed, comments from the WOG peer review have been addressed, and the licensee has procedures in place to periodically update the PRAs and to incorporate the updated versions of the PRA into the RI-ISI program.

The NRC staff did not review the PRA analysis to assess the accuracy of the quantitative estimates. Quantitative results of the PRA are used, in combination with a quantitative characterization of the pipe segment failure likelihood, to support the assignment of segments into broad safety significance categories reflecting the relative importance of pipe segment failures on CDF and LERF. Inaccuracies in the models or assumptions large enough to invalidate the broad categorizations developed to support the RI-ISI should have been identified in the licensee's or in the NRC staff's review. Minor errors or inappropriate assumptions will only affect the consequence categorization of a few segments and will not invalidate the general results or conclusions. The continuous use and maintenance of the PRA provides further opportunities to identify inaccuracies and inappropriate assumptions, if any, in the PRA models. The NRC staff finds that the quality of the PRA is sufficient to support the submittal.

The reported changes in CDF and LERF are provided in the following Table.

	BVPS-1	BVPS-2
ΔCDF without operator action	-2.6E-8/year	-2.2E-8/year
ΔCDF with operator action	-2.9E-8/year	-8.0E-9/year
ΔLERF without operator action	-2.5E-9/year	-9.0E-11/year
ΔLERF with operator action	-2.4E-9/year	-1.6E-10/year

The licensee did not submit estimates for the other risk change criteria in Section 4.4.2 of WCAP-14572, Revision 1-NP-A, but stated in Reference 1 that all the changes in risk calculations were performed according to the guidance on page 213 of the WCAP-14572, Revision 1-NP-A (as applicable), and all four criteria for evaluating the results were applied. Based on the use of the approved methodology and on the reported results, the NRC staff finds that any change in risk associated with the implementation of the RI-ISI program is small and consistent with the intent of the Commission's Policy Statement (Reference 12), and is, therefore, consistent with RG 1.178.

3.4 Integrated Decision Making

The objective of ISI required by the Code is to identify service-induced conditions (i.e., flaws or other degradation) that may challenge the structural integrity of components and adversely impact plant safety. Therefore, the RI-ISI program must meet this objective to be found acceptable for use. Further, since the RI-ISI program is partially based on an *inspection-for-cause* philosophy, examination element selection should target specific degradation mechanisms. Section 4 of WCAP-14572, Revision 1-NP-A, provides guidelines for the areas and/or volumes to be inspected as well as the examination method, acceptance standard, and evaluation criteria for each degradation mechanism.

The proposed RI-ISI program presents an integrated approach that considers in concert the traditional engineering analysis, the risk evaluation, and the implementation and performance monitoring of piping. This is consistent with the guidelines of RG 1.178. The selection of pipe segments to be inspected is described in References 1 using the results of the risk category rankings and other operational considerations. Table 3.7-1 for BVPS-1 and 2 (Reference 1) identified the number of segments in the different systems that met or exceeded the quantitative criteria to be assigned HSS. Segments defined as HSS were those with a relative risk reduction worth (RRW) of ≥1.005 for any of the four risk metrics, while LSS segments had calculated RRW values of <1.005 for all the risk metrics. Inspection of the table indicated that in some systems, segments quantitatively classified as HSS (RRW>1.005) were subsequently changed to LSS by the expert panel. The tables also identified the number of LSS segments that were changed to HSS by the expert panel. The WCAP methodology provides the following guidance on the reclassification of the safety significance of segments by the expert panel.

> The expert panel (such as the expert panel used for the Maintenance Rule) evaluates the risk-informed results and makes the final decision by identifying the high-safety-significant pipe segments for ISI. The piping segments that have been determined by quantitative methods to be high safety significant should not be classified lower by the expert panel without sufficient justification that is documented as part of the program. The expert panel should be focused primarily on adding piping to the higher classification.

In Reference 4, the licensee stated that 35 (18 BVPS-1 and 17 BVPS-2) segments were reclassified from HSS to LSS by the expert panel. The licensee explained that the expert panel identified conservatism in the SRRA failure probability associated with two of the 35 segments and that removal of this conservatism yielded RRW values below the HSS guideline values.

The remaining 33 segments were initially reclassified from HSS to LSS based on discarding the "without human action" RRW when that RRW is the only RRW greater than 1.005. This reclassification is based on a high degree of confidence by the expert panel that the operators could appropriately recover from the event. In Reference 4, the licensee explained that 15 of the 35 segments were reclassified from LSS back to HSS based on anticipated difficulties for the operators to identify what piping had failed and lack of specific documentation quantifying the response time available to mitigate the consequences of the failures. In Reference 4, the licensee also provided justification for classifying the final 18 segments as LSS. The NRC staff finds that the justification provided, and to be incorporated into the expert panel documentation, allows an independent reviewer to reach the same conclusion. Based on the information provided, the NRC staff finds there is a high probability that the operators would initiate proper action within the time that the action will be effective, and, therefore, finds the reclassification consistent with the approved methodology and acceptable.

The selection of structural elements to be inspected is described in Section 3.8 of Reference 1. The WCAP-14572, Revision 1-NP-A, methodology includes a statistical calculation that is applied to determine the number of examinations required in the population of HSS butt welds, excluding susceptible locations, to satisfy certain statistical criteria. The licensee applied this methodology to the population of butt welds except for a small population of welds that the licensee determined could not be appropriately evaluated using the SRRA code. This deviation, and the NRC staff's concurrence of its use, is discussed in Section 3.2 of this safety evaluation. This approach is 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 public health and safety, and, therefore, this approach is acceptable. The NRC staff finds that the licensee's selection process uses "defense-in-depth" considerations and is consistent with the WCAP-14572, Revision 1-NP-A.

Based on a review of the cited portion of WCAP-14572, Revision 1-NP-A, the NRC staff concludes that the examination methods are appropriate since they are selected based on specific degradation mechanisms, pipe sizes, and materials of concern. The licensee reported no deviations in this area from the WCAP-14572, Revision 1-NP-A, methodology; therefore, it is acceptable.

3.5 Implementation and Monitoring

Implementation and performance monitoring strategies require careful consideration by the licensee and are addressed in Element 3 of RG 1.178 and SRP 3.9.8. The objective of Element 3 is to assess performance of the affected piping systems under the proposed RI-ISI program by implementing monitoring strategies that confirm the assumptions and analyses used in the development of the RI-ISI program. To approve an alternative pursuant to 10 CFR 50.55a(a)(3)(i), implementation of the RI-ISI program, including inspection scope, examination methods, and methods of evaluation of examination results, must provide an adequate level of quality and safety.

In Reference 1, the licensee stated that upon approval of the RI-ISI program, procedures that comply with the WCAP-14572, Revision 1-NP-A, guidelines will be prepared to implement and monitor the RI-ISI program. The licensee confirmed that the applicable portions of the Code not affected by the change, e.g., inspection methods, acceptance guidelines, pressure testing, corrective measures, documentation requirements, and quality control requirements, would be retained.

The licensee stated in Section 4 of Reference 1 that the RI-ISI program is a living program and its implementation will require feedback of new relevant information to ensure the appropriate identification of HSS piping locations. Reference 1 also stated that as a minimum, risk-ranking of piping segments will be reviewed and evaluated every ISI period and that significant changes may require more frequent adjustments as directed by any NRC Bulletin or Generic Letter or by industry and plant-specific feedback. The NRC staff finds that the proposed process for RI-ISI program updates meets the guidelines of RG 1.174 that risk-informed applications should include performance monitoring and feedback provisions; therefore, the process for program updates and monitoring is acceptable.

As discussed in Section 3.2 of this safety evaluation, the NRC staff does not find the licensee's method to estimate the failure frequency of piping segments with multiple pipe sizes an acceptable alternative to the approved methodology. Any RI-ISI program that uses the results of calculations based on the unapproved method to review or adjust the safety significance of piping locations will require NRC staff review and approval of a request for relief pursuant to 10 CFR 50.55a(a)(3)(i).

The licensee is currently in the third 10-year ISI interval at BVPS-1 and the second 10-year ISI interval at BVPS-2. Both units are at present, within the second 40-month inspection period of the respective intervals. The licensee intends to integrate the RI-ISI program into the existing Code ISI program, i.e., the RI-ISI program will supercede the Code for selection of piping welds in Categories B-F, B-J, C-F-1 and C-F-2. The licensee plans to perform inspections on one third of the RI-ISI selected examinations by the end of the second (current) inspection period, and two thirds of the RI-ISI examinations by the end of the current interval. The completion of approximately one third of all examinations during each of the inspection periods is the same as existing Code requirements. To determine the selection and distribution of examination locations for the remainder of the current interval, variables such as failure mechanisms, industry and site-specific experience, inspection history, and stress were considered. The NRC staff finds the logic used for selecting the extent of examinations to be performed during the remainder of the third 10-year interval at BVPS-1 and the remainder of the second 10-year interval at BVPS-2 to be consistent with ASME Code requirements, and is, therefore, acceptable.

4.0 CONCLUSION

Section 55a(a)(3)(i) of Part 50 permits alternatives to regulatory requirements when authorized by the NRC if the applicant demonstrates that the alternative provides an acceptable level of quality and safety. In this case, the licensee's proposed alternative is to use the RI-ISI process described in the NRC-approved WCAP-14572, Revision 1-NP-A. The licensee identified three deviations from the approved methodology and the NRC staff identified an additional deviation. Inclusion of the parameter uncertainty in the initial calculation of the RRW values, crediting of leak detection for several non-RCS piping segments, and determination of sample size in three segments (in BVPS-1) without application of the statistical method were identified by the licensee and found acceptable by the NRC staff as discussed in Section 3.2. The fourth deviation, whereby the failure frequency for segments made up of multiple pipe sizes is developed by combining limiting inputs for each different sized sub-segment and not for the entire segment, is not endorsed by the NRC staff as a generally acceptable modification of the WCAP methodology. In References 5 and 6 (see licensee's regulatory commitment), the licensee reevaluated these multiple pipe-size segments and modified the proposed RI-ISI program so that the final proposed program is the same as would have been developed if the approved methodology had been used. Consequently, the results of our review indicate that the licensee's proposed RI-ISI program is consistent with WCAP-14572, Revision 1-NP-A.

The NRC staff finds that the results of different elements of the engineering analysis are considered in an integrated decision-making process. The impact of the proposed changes in the ISI program is founded on the adequacy of the engineering analysis and acceptable estimation of changes in plant risk in accordance with RG 1.174 and RG 1.178 guidelines.

The licensee's methodology also considers implementation and performance monitoring strategies. Inspection strategies ensure that failure mechanisms of concern have been addressed and there is adequate assurance of detecting damage before structural integrity is affected. The risk significance of piping segments is taken into account in defining the inspection scope for the RI-ISI program.

System pressure tests and visual examination of piping structural elements will continue to be performed on all Code Class 1 and 2 systems in accordance with the ASME Code, Section XI, program. The RI-ISI program applies the same performance measurement strategies as existing ASME Code requirements.

The licensee's risk-informed methodology provides for conducting an analysis of the proposed changes using a combination of engineering analyses with supporting insights from a PRA. Defense-in-depth and quality are not degraded in that the methodology provides reasonable confidence that any reduction in existing inspections will not lead to degraded piping performance when compared to existing performance levels. Inspections are focused on locations with active degradation mechanisms as well as selected locations that monitor the performance of system piping.

As discussed above, the NRC staff's review of the licensee's proposed RI-ISI program concludes that it is an acceptable alternative to the current ISI program for Code Class 1, Categories B-F and B-J piping welds, and for Code Class 2, Categories C-F-1 and C-F-2 piping welds. In addition, the licensee has met the applicable criteria described in SRP 3.9.8. Based on risk considerations and the criteria of the SRP, it is concluded that the licensee's proposed alternative will provide an acceptable level of quality and safety. Therefore, pursuant to 10 CFR 50.55a(a)(3)(i), the licensee's proposed RI-ISI program is authorized for the remainder of the third 10-year interval at BVPS-1 and the second 10-year inspection interval at BVPS-2. However, this authorization does not constitute NRC approval of the licensee's method to estimate the failure frequency for segments made up of multiple pipe sizes. RI-ISI programs are living programs requiring feedback of new relevant information to ensure the appropriate identification of high safety-significant piping locations. Any RI-ISI program that uses the results of calculations based on the unapproved method to review or adjust the safety significance of piping locations will require NRC staff review and approval of a request for relief pursuant to 10 CFR 50.55a(a)(3)(i).

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