January 26, 2001

Mr. David A. Christian
Senior Vice President - Nuclear
Virginia Electric and Power Company
5000 Dominion Blvd.
Glen Allen, Virginia 23060

SUBJECT: REQUEST TO USE ALTERNATIVE RISK-INFORMED INSERVICE INSPECTION (RI-ISI) PROGRAM AT SURRY UNIT 2 (TAC NO. MA8835)

Dear Mr. Christian:

The purpose of this letter is to grant the relief you requested to implement a RI-ISI program as an alternative to your current Inservice Inspection program at Surry Unit 2.

In letters dated April 27 and September 27, 2000, Virginia Electric and Power Company (VEPCO) requested approval of an alternative RI-ISI program for Code Class 1 piping at Surry Unit 2. Your proposed program was developed in accordance with Westinghouse Owners Group topical report WCAP-14572, Revision 1-NP-A, using the Nuclear Energy Institute template methodology. The results of our review indicate that your proposed RI-ISI program is an acceptable alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI for inservice inspection of Code Class 1 piping, Category B-F and B-J welds. Therefore, VEPCO's request for relief is authorized pursuant to 10 CFR 50.55a(a)(3)(i) because the alternative provides an acceptable level of quality and safety.

In addition, VEPCO requested performing visual VT-2 examinations each refueling outage as an alternative to the volumetric examinations specified in Code Case N-577 and in WCAP-14572, Revision 1-NP-A for those high safety significant ASME Code Class 1 socket welds identified in the RI-ISI program. The NRC staff concurs that volumetric examination of socket welds is inconclusive and impractical due to the geometric limitations imposed by a socket weld. The staff also concurs that it is not useful to perform Code-required surface examination of socket welds due to the absence of outside surface-initiated flaws. Therefore, VEPCO's proposed alternative examination method is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that performing either volumetric or surface examinations of these socket welds would result in unusual difficulty without a compensatory increase in the level of quality and safety.

The recent event at the V. C. Summer facility in which through-wall cracking was discovered in a 34-inch main coolant loop hot leg to reactor pressure vessel nozzle weld may call into question the conclusions that have been made regarding the frequency of large-bore piping examination. The NRC staff will evaluate the results of the V. C. Summer root cause analysis to determine whether any generic conclusions apply to this evaluation, for example to the frequency of large-bore piping examination. If generic implications are found, the NRC staff will take actions, as appropriate.

Our detailed evaluation and conclusions are documented in the enclosed Safety Evaluation. We are closing TAC No. MA8835 with this letter.

Sincerely,

/RA/

Richard L. Emch, Jr., Chief, Section 1
Project Directorate II
Division of Project Licensing Management
Office of Nuclear Reactor Regulation

Docket No. 50-281

Enclosure: As stated

cc w/encl: See next page

Our detailed evaluation and conclusions are documented in the enclosed Safety Evaluation. We are closing TAC No. MA8835 with this letter.

Sincerely,

/RA/

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RISK-INFORMED INSERVICE INSPECTION PROGRAM

VIRGINIA ELECTRIC AND POWER COMPANY

SURRY POWER STATION, UNIT 2

DOCKET NO. 50-281

1.0 INTRODUCTION

In a submittal dated April 27, 2000, as supplemented September 27, 2000 (Ref. 1), the Virginia Electric and Power Company (the licensee) proposed a risk-informed inservice inspection (RI-ISI) program as an alternative to a portion of their current inservice inspection (ISI) program. The scope of the RI-ISI program is limited to the American Society of Mechanical Engineers (ASME) Code Class 1 piping (Categories B-F and B-J welds) only. The licensee's RI-ISI program was developed in accordance with the methodology contained in the Westinghouse Owners Group topical report WCAP-14572, Revision 1-NP-A (Ref. 2), which was previously reviewed and approved by the staff. The RI-ISI program proposed by the licensee was made pursuant to Title 10 of the *Code of Federal Regulation* (10 CFR) Section 50.55a(a)(3)(i).

2.0 BACKGROUND

2.1 Applicable Requirements

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 Boiler and Pressure Vessel Code, "Rules for Inservice Inspection of Nuclear Power Plant Components" (hereinafter called Code) and applicable addenda, except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulation 10 CFR 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 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.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the 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 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. For Surry Unit 2, the applicable edition of the Code for the third 10-year ISI interval, which began on May 10, 1994, is the 1989 edition.

Surry Unit 2 is currently in the second period of the third 10-year ISI interval. The Code requires in part that for each successive 10-year ISI interval, 100% of Category B-F welds and 25% of Category B-J welds for the Code Class 1 piping greater than 1-inch in nominal diameter be selected for volumetric and/or surface examination, based on existing stress analyses and cumulative usage factors.

2.2 Summary of Proposed Approach

In the licensee's proposed RI-ISI program, piping failure potential estimates were determined using a software program contained in Supplement 1 to Ref. 2, entitled "Westinghouse Structural Reliability and Risk Assessment (SRRA) Model for Piping Risk-Informed Inservice Inspection," which 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 program maintains the fundamental requirements of the Code, such as examination technology, examination frequency, and examination acceptance criteria. 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 planned for complete implementation of the RI-ISI program in the third ISI interval. Other non-related portions of the Code requirements, as well as the on-going augmented inspection programs at Surry Unit 2, will remain unchanged. The RI-ISI program follows a previously approved methodology delineated in Ref. 2.

3.0 EVALUATION

Pursuant to 10 CFR 50.55a(a)(3), the staff has reviewed and evaluated the licensee's proposed RI-ISI program, including those portions related to the applicable methodology and processes contained in Ref. 2, based on guidance and acceptance criteria provided in Regulatory Guides (RGs) 1.174 (Ref. 3) and 1.178 (Ref. 4) and in Standard Review Plan (SRP) Chapter 3.9.8 (Ref. 5).

3.1 Proposed Changes to the ISI Program

The scope of the licensee's proposed RI-ISI program is limited to ASME Class 1 piping only, which consists of Category B-J piping welds and Category B-F dissimilar metal vessel nozzle welds. The RI-ISI program was proposed as an alternative to the existing ISI program, which 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 (Ref. 1).

During the course of its review, the staff reviewed the proposed RI-ISI program against the guidelines contained in previously approved WCAP-14572, Revision 1-NP-A (Ref. 2), which state in part that the SRRA computing models are to be used to estimate the failure

probabilities of the structural elements most likely to fail in each of the piping segments. The licensee performed preliminary evaluations to estimate piping failure potentials using the Westinghouse SRRA software program and then the licensee's engineering team members and expert panel made final determinations on failure probability estimates, based on industry and plant-specific experience and other relevant information. This is consistent with the guidelines in the previously approved WCAP-14572, Revision 1-NP-A. The staff also notes that the same RI-ISI methodology has been implemented at Surry Unit 1, which has been previously reviewed and approved. Thus, the staff concludes that the licensee's application of the WCAP-14572, Revision 1-NP-A approach is an acceptable alternative to the current piping ISI requirements with regard to the number, locations, and methods of inspections and provides an acceptable level of quality and safety pursuant to 10 CFR 50.55a(a)(3)(i).

In Table 5-1 of the submittal, a comparison of inspection location selection between the current ISI program and the proposed RI-ISI program is provided. The staff finds that the information submitted adequately defines the proposed changes to the RI-ISI program.

3.2 Engineering Analysis

In accordance with the guidance provided in RGs 1.174 and 1.178 (Refs. 3 and 4), the licensee provided the results of an engineering analysis of the proposed changes, using a combination of traditional engineering analysis and a PRA. The licensee stated that the results of the engineering analysis demonstrate that the proposed changes are consistent with the principles of defense-in-depth and that adequate safety margins will be maintained. This is 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. The proposed RI-ISI program will result in an 84% reduction of required nondestructive examination locations, from a total of 313 locations in the current ISI program to a total of 50 locations in the RI-ISI program (Ref. 1, Table 5-1). Another 26 welds will receive focused visual VT-2 examinations. For volumetric examination of butt welds, the RI-ISI program selected 6 B-F welds and 44 B-J welds from a total of 477 butt welds, which represents approximately 10.5% of the butt weld population.

The licensee stated that for Code Class 1 piping, other non-related portions of the Code requirements, as well as the on-going augmented inspection programs, will remain unaffected by the proposed RI-ISI program. This is consistent with the approved WCAP-14572, Revision 1-NP-A.

The licensee requested performing visual VT-2 examinations during each refueling outage as a replacement of the volumetric examinations specified in Code Case N-577 and in WCAP-14572, Revision 1-NP-A, for those high safety significant (HSS) ASME Code Class 1 socket welds identified in the RI-ISI program. The licensee indicated that Code Case N-577 has been revised to allow the substitution of the VT-2 examination method for all damage mechanisms on socket welds selected as HSS. The request is reasonable because volumetric examination is inconclusive and impractical due to the geometric limitations imposed by a socket weld. However, the staff notes that Table IWB-2500-1 of the Code requires surface examination, not volumetric examination, at the socket welds, and surface examination (i.e., liquid penetration examination) is an effective method for discovery of potential piping outside surface initiated flaws - of specific concern, flaws induced by low-cycle but high-bending-stress thermal fatigue or by external chloride stress corrosion cracking (ECSCC). The licensee indicated that the Code Class 1 socket weld piping is not located in areas that are subject to an

environment promoting ECSCC and an outside surface initiated flaw has a very low probability of occurrence due to the inclusion of thermal cyclic loads in the piping design. Thus, these conditions do not exist in the Code Class 1 piping at Surry Unit 2. As for a potential outside surface flaw caused by vibration induced fatigue, such a flaw is likely to take a long period for initiation. After the initiation phase, the flaw will likely propagate rapidly and cause the pipe to leak. Thus, the staff concludes that to conduct visual VT-2 examination is sufficiently effective, and therefore acceptable. The staff notes that the revised Code Case N-577 has neither been issued nor been reviewed and approved by the NRC. Thus, the approval of this request is based on the technical soundness of applying visual VT-2 to Surry Unit 2 specific conditions, and should not be considered as an endorsement of the Code Case. Pursuant to 10 CFR 50.55a(a)(3)(ii), the staff concurs that performing volumetric or surface examinations of these socket welds would result in unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the request to conduct VT-2 examinations as an alternative in each refueling outage for Category B-J socket welds is acceptable.

Piping systems within the scope of the proposed RI-ISI program were divided into piping segments. A pipe segment is defined as a portion of pipe length whose failure at any location within the segment will lead to the same consequence. Pipe segments are separated by flow splits and locations of pipe size changes, and include piping to a point at which a pipe break could be isolated. This is consistent with the SRP 3.9.8 guideline to confirm that a systematic process was used to identify and group piping systems into segments.

Piping failure mechanisms identified by the licensee include fatigue, stress corrosion cracking, thermal striping/stratification, and vibratory fatigue. The licensee performed preliminary evaluations to estimate piping failure potentials using the Westinghouse SRRA software program, and then the licensee's engineering team members and expert panel made final determinations on failure probability estimates based on industry and plant-specific experience and other relevant information. This is consistent with the guidelines in the previously approved WCAP-14572, Revision 1-NP-A, and in conformance with SRP 3.9.8 that the failure potential is determined based on appropriate design and operational information, and the methodology and results are reviewed and approved by the plant expert panel.

The licensee developed the consequence of each segment break based on the direct and indirect effects of the segment failure. The licensee reported no deviations from the consequence characterization methodology stated in the previously approved WCAP-14572, Revision 1-NP-A, and their analyses are therefore acceptable.

3.3 Probabilistic Risk Assessment

The licensee used the June 1998 version of its Level 1 and Level 2 PRA to support the RI-ISI submittal. The current estimates of core damage frequency (CDF) and large early release frequency (LERF) are 3.83E-5/yr and 2.72E-6/yr, respectively. The PRA is an updated version of the original Individual Plant Examination (IPE) submitted to the NRC in August 1991. The approved WCAP-14572, Revision 1-NP-A, requires that functions relied upon to mitigate external events and fires and to mitigate transients during operation modes outside the scope of the PRA be systematically included in the categorization by the engineering team members and the expert panel. The licensee did not report a deviation in this area and therefore the use of a PRA derived from an internal events, full power operation IPE is acceptable.

The staff evaluation report, dated December 16, 1993, concluded that the IPE satisfied the intent of Generic Letter 88-20. Since the IPE, the PRA models have been updated on an 18-month interval that coincides with the refueling outages to ensure that the risk analyses performed in support of plant operation reflect the current plant configuration and operational practices. The updates to the models are documented and reviewed in accordance with the licensee's administrative procedures. The continuous use and well-documented maintenance of the PRA provides further opportunities to identify inaccuracies, if any, in the PRA models or assumptions.

The 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 RI-ISI should have been identified in the licensee or the staff reviews. 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 staff finds that the quality of the PRA is sufficient to support the submittal.

The licensee reported no deviations from the WCAP-14572, Revision 1-NP-A, methodology associated with the risk ranking of the pipe segments and the subsequent change in risk calculations. The submittal included estimates on the change in CDF and LERF associated with replacing the current ASME Section XI weld inspection locations for Code Class 1 piping with the proposed RI-ISI inspection locations. The change in CDF is estimated to be -2E-8/yr with and without operator action. The change in LERF is estimated to be 0 (i.e., less than the third significant digit) with operator action and -1E-10/yr without operator action. The licensee did not submit estimates for the other risk change criteria in Section 4.4.2 of the WCAP-14572, Revision 1-NP-A, and did not report any deviation from these criteria. Based on the reported quantitative results, the staff finds that any increase in risk associated with the implementation of the RI-ISI program is small and consistent with the intent of the Commission's Policy Statement and, therefore, is consistent with RG 1.178.

3.4 Integrated Decision Making

The proposed RI-ISI program is consistent with WCAP-14572, Revision 1-NP-A, and presents an integrated approach that considers in concert the traditional engineering analysis, risk evaluation, and the implementation and performance monitoring of piping. This is in compliance with the guidelines of RG 1.178.

The selection of pipe segments to be inspected is described in Section 3.8 of the submittal using the results of the risk category rankings and other operational considerations. Table 5-1 of the submittal provides a summary table comparing the number of inspections required under the existing ASME Section XI inservice inspection program with the alternative RI-ISI program. The licensee used the methodology described in WCAP-14572, Revision 1-NP-A, to guide the selection of examination elements within the piping segments.

WCAP-14572, Revision 1-NP-A, describes targeted examination volumes (typically associated with welds) and methods of examination based on the type(s) of degradation expected. The staff has reviewed these guidelines and has determined that, if implemented as described, the

RI-ISI examinations should result in improved discovery of service-related discontinuities over that currently required by ASME Section XI.

The staff finds the location selection process to be acceptable since it is consistent with the process approved for the WCAP-14572, Revision 1-NP-A, and takes into account defense-in-depth.

The objective of ISI required by ASME Section XI is to identify conditions (i.e., flaw indications) that are precursors to leaks and ruptures in the pressure boundary that may impact plant safety. Therefore, the RI-ISI program must meet this objective to be found acceptable for use. Further, since the risk-informed program is based on inspection for cause, 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 standard for each degradation mechanism. Based on a review of the cited portion of WCAP-14572, Revision 1-NP-A, the staff concludes that the examination methods are appropriate since they are selected based on specific degradation mechanisms, pipe sizes, and materials of concern.

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 the submittal, 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 ASME Code not affected by the change, such as inspection methods, acceptance guidelines, pressure testing, corrective measures, documentation requirements, and quality control requirements would be retained.

The licensee stated in Section 4 of the submittal 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. The submittal also states that as a minimum, risk ranking of piping segments will be reviewed and adjusted on an ASME Code-defined ISI period basis and that significant changes may require more frequent adjustment as directed by NRC bulletin or generic letter requirements or by industry and plant-specific feedback.

The proposed periodic reporting requirements meet existing ASME Code requirements and applicable regulations and, therefore, are considered acceptable. The 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 is acceptable.

4.0 CONCLUSION

10 CFR 50.55a(a)(3)(i) 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 risk-informed process described in the NRC-approved report WCAP-14572, Revision 1-NP-A. As discussed in Section 3.0 above, the staff concludes that the licensee's proposed RI-ISI program, as described in the submittal, will provide an acceptable level of quality and safety with regard to the number of inspections, locations of inspections, and methods of inspection.

The staff finds that the results of the 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 Surry Unit 2 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 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 Surry Unit 2 risk informed methodology provides for conducting an analysis of the proposed changes using a combination of engineering analysis 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.

In addition, the licensee requested performing visual VT-2 examinations each refueling outage as an alternative to the volumetric examinations specified in Code Case N-577 and in WCAP-14572, Revision 1-NP-A, for those HSS ASME Code Class 1 socket welds identified in the RI-ISI program. The staff concurs that volumetric examination of socket welds is inconclusive and impractical due to the geometric limitations imposed by a socket weld. The staff also concurs that to perform Code required surface examination of socket welds is not useful due to the absence of outside surface initiated flaws. Therefore, the licensee's proposed alternative examination method is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that performing either volumetric or surface examinations of these socket welds would result in unusual difficulty without a compensating increase in the level of quality and safety.

As discussed above, the staff's review of the licensee's proposed RI-ISI program concludes that the program is an acceptable alternative to the current ISI program, which is based on ASME Code, Section XI requirements for Code Class 1, Categories B-F and B-J welds. Therefore, the licensee's proposed RI-ISI program is authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that the request provides an acceptable level of quality and safety. This safety evaluation

authorizes complete implementation of the proposed RI-ISI program within the third 10-year ISI interval.

5.0 REFERENCES

1. Letter, dated April 27, 2000, as supplemented September 27, 2000, L. N. Hartz (Virginia Electric and Power Company, Vice President - Nuclear Engineering and Services) to U.S. Nuclear Regulatory Commission, containing *Risk-Informed Inservice Inspection (RI-ISI) Program for ASME Code Class 1 Piping - Surry Power Station Unit 2*.

2. WCAP-14572, Revision 1-NP-A, *Westinghouse Owners Group Application of Risk-Informed Methods to Piping Inservice Inspection Topical Report*, February 1999.

3. NRC Regulatory Guide 1.174, *An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis*, July 1998.

4. NRC Regulatory Guide 1.178, *An Approach for Plant-Specific Risk-Informed Decision Making: Inservice Inspection of Piping*, September 1998.

5. NRC NUREG-0800, Chapter 3.9.8, *Standard Review Plan for Trial Use for the Review of Risk-Informed Inservice Inspection of Piping*, May 1998.

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Date: January 26, 2001

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