June 15, 2000

Mr. James A. Hutton
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Nuclear Group Headquarters
Correspondence Control Desk
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SUBJECT: REQUEST FOR RELIEF FROM PERFORMING AUGMENTED INSPECTIONS OF THE CIRCUMFERENTIAL REACTOR VESSEL SHELL WELDS, PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3 (TAC NOS. MA8195, MA8196)

Dear Mr. Hutton:

By letter dated February 7, 2000, PECO Energy Company (PECO, the licensee) requested relief from complying with the following requirements: (1) augmented inspection requirements of the reactor pressure vessel (RPV) shell welds (Section XI Category B-A, Inspection Item B1.11), as required by 10 CFR 50.55a(g)(6)(ii)(A)(*2*); (2) inservice inspection (ISI) requirements for circumferential RPV shell welds contained in the 1980 Edition of Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), inclusive of the Winter 1981 Addenda; (3) ISI requirements for the current third 10-year interval as specified in the 1989 Edition of Section XI to the ASME Code; and (4) the ISI requirements specified in all future versions of the ASME Code through the end of the current operating license for the Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3. As an alternative to these requirements, PECO is seeking to permanently defer these inspections for the remaining licensed life for PBAPS 2 and 3.

The staff has reviewed PECO's basis for permanently deferring the volumetric examinations of the circumferential shell welds in the PBAPS RPVs. The staff has determined that PECO's alternative assessments are consistent with the methodology in Topical Report BWRVIP-05, and with the evaluation criteria stated in the staff's safety evaluation (SE) on BWRVIP-05 dated June 28, 1998. The staff concludes, as delineated in the enclosed safety evaluation, that the alternative assessments performed by PECO provide an acceptable basis for permanently deferring the volumetric inspections of the circumferential welds in the PBAPS 2 and 3 RPVs.

The staff concludes that the alternatives proposed by PECO provide an acceptable level of quality and safety and are consistent with the provisions of 10 CFR 50.55a(a)(3)(i) and 10 CFR 50.55a(g)(6)(ii)(A)(5), and are acceptable by law, and that PECO may permanently defer conducting the volumetric examinations of the circumferential RPV welds for the remaining time in the current 40-year operating terms for the units.

Sincerely,

/RA/

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-277 and 50-278

Enclosure: Safety Evaluation

cc w/encl: See next page

The staff concludes that the alternatives proposed by PECO provide an acceptable level of quality and safety and are consistent with the provisions of 10 CFR 50.55a(a)(3)(i) and 10 CFR 50.55a(g)(6)(ii)(A)(5), and are acceptable by law, and that PECO may permanently defer conducting the volumetric examinations of the circumferential RPV welds for the remaining time in the current 40-year operating terms for the units.

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James W. Clifford, Chief, Section 2
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Docket Nos. 50-277 and 50-278

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR THE PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3

PECO ENERGY COMPANY

DOCKET NOS. 50-277 AND 50-278

1.0 INTRODUCTION

Section 50.55a(g)(6)(ii)(A) to Title 10 of the Code of Federal Regulations (10 CFR 50.55a(g)(6)(ii)(A)) requires nuclear licensees to augment their inspection programs by implementing once, as part of the inservice inspection interval (ISI) that is in effect on September 8, 1992, examinations of reactor pressure vessel (RPV) shell welds, as specified in Item B1.10 of Examination Category B-A, "Pressure Retaining Welds in the Reactor Vessel, to Table IWB-2500-1 in Subsection IWB of the 1989 Edition of Section XI, American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code). However, 10 CFR 50.55a(g)(6)(ii)(A)(*5*) allows licensees to propose alternatives to the augmented inspection requirements when the requirements are determined to be impractical, and if the proposed alternatives provide an acceptable level of quality and safety in lieu of complying with the requirements of the rule.

On February 7, 2000, PECO Energy Company (henceforth PECO or the licensee) submitted a request seeking approval for an alternative examination program to the inservice inspection requirements for circumferential shell welds in the RPVs of the Peach Bottom Atomic Power Station (PBAPS), Units 2 and 3. The U.S. Nuclear Regulatory Commission's (NRC's) and industry's bases and guidelines for submitting this request are summarized in Section 2.0 of this safety evaluation (SE). The specific details of PECO's relief request and the staff's evaluation of this request are summarized in Section 3.0 of this SE.

2.0 BASES FOR SUBMITTING REQUESTS FOR RELIEF FROM COMPLYING WITH THE AUGMENTED INSPECTION REQUIREMENTS OF 10 CFR 50.55a(g)(6)(ii)(A)(*2*)

Technical Report BWRVIP-05, "BWR Vessel and Internals Project, BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations," September 1995, provides the technical basis for permanently deferring the augmented inspections of circumferential welds in the RPV shells of boiling water reactors (BWRs). In the report, the Boiling Water Reactor Vessel and Internals Project (BWRVIP) concluded that the probabilities of failure for BWR RPV circumferential shell welds are orders of magnitude lower than that for the longitudinal shell welds. To assess the BWRVIP safety assessment, the NRC conducted an independent risk-informed, probabilistic fracture mechanics assessment (PFMA) of the analysis presented in the

BWRVIP-05 document.[1] In the staff's assessment, the staff conservatively calculated the probability that an RPV shell weld would catastrophically fail during the licensed operating term for a BWR nuclear plant. In the assessment, the NRC used the FAVOR Code to perform the PFMA. The staff calculates the final failure probability for an RPV shell weld as the product of frequency for the critical (limiting) transient event and the conditional failure probability for the weld using the limiting conditions from that event.

For the analysis, the staff identified that a cold overpressure event in a foreign reactor was the limiting pressure and temperature event for BWR RPVs. By the staff's calculations, the staff estimated that the probability for the occurrence of the limiting overpressurization transient was $1X10^{-3}$ per reactor-year. The staff then determined the conditional probabilities of failure for longitudinal and circumferential welds in ABB-Combustion Engineering (CE), Chicago Bridge and Iron Works (CB&I), and Babcock and Wilcox (B&W) fabricated vessels using the pressures and temperatures from the limiting event. The conditional failure probabilities for vessel welds were calculated as a function of a nil ductility reference temperature (Mean RT_{ndt} value) for the welds.[2]

Table 2.6-4 of the staff's PFMA identifies the conditional failure probabilities for the bounding reference cases for longitudinal and circumferential welds in CB&I, CE and B&W fabricated vessels. The materials and neutron radiation parameters used by the staff in calculating the conditional probability failures for the reference cases were also identified in Table 2.6-4 of the staff's PFMA. According to Table 2.6-4, B&W fabricated vessels were determined to have the highest conditional probability of failure for circumferentially oriented flaws ($8.17x10^{-5}$ per reactor-year). For circumferentially oriented flaws in circumferential shell welds fabricated by CB&I, the conditional probability of failure was somewhat lower ($1.0x10^{-6}$ per reactor-year as calculated by the BWRVIP; $2x10^{-7}$ per reactor-year as calculated by the NRC). The corresponding Mean RT_{ndt} value used to calculate the conditional probability of failure for the CB&I reference case was 44.5 °F. Using this data, the staff calculated the best-estimate failure probability for CB&I fabricated circumferential welds to be $2x10^{-10}$ per reactor-year.[3]

The staff considers that when the adjusted reference temperature (RT_{ndt}) value for an RPV shell weld is less than the Mean RT_{ndt} value for its corresponding limiting weld reference case study (as specified in Table 2.6-4 of the PFMA), the shell weld is considered to have less embrittlement than the corresponding weld in the case study, and therefore to have a conditional probability of failure less than or equal to that calculated for the reference case study.

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1 The staff's PFMA of BWRVIP-05 is documented in a letter dated June 28, 1998, to Mr. Carl Terry, Chairman of the BWRVIP.

2 The key parameters in the analysis for calculating the Mean RT_{ndt} values are the initial RT_{ndt} value for the weld, the end-of-license mean neutron fluence, and the mean chemistry (percent copper and nickel) of the welds. The methods for calculating the Mean RT_{ndt} values are consistent with the methods in Regulatory Guide 1.99, Revision 2.

3 This value is the product of the conditional probability of failure for the CB&I reference case (2.0E-7 per reactor-year) and the estimated frequency for the limiting event (1E-3 per reactor-year).

3.0 EVALUATION OF THE PROPOSED ALTERNATIVES TO THE AUGMENTED INSPECTION REQUIREMENTS FOR CIRCUMFERENTIAL WELDS IN THE PBAPS RPVs

3.1 Request for Relief

PECO is requesting relief from performing augmented volumetric examinations of the circumferential shell welds in the PBAPS RPVs. Specifically, PECO is seeking relief from complying with the following requirements:

1. examination of the RPV circumferential shell welds (Section XI Examination Category B-A, Item B1.11) as required by 10 CFR 50.55a(g)(6)(ii)(A)(*2*)

2. ISI requirements for circumferential welds contained in the ASME Code, Section XI, 1980 Edition through Winter 1981 Addenda

3. ISI requirements for circumferential welds contained in the third 10-year interval, ASME Code, Section XI, 1989 Edition,

4. ISI requirements for circumferential welds contained in all future versions of the ASME Code through the end of the current operating licenses for PBAPS Units 2 and 3

3.2 Applicable Requirements

Pursuant to the requirements of 10 CFR 50.55a(g)(4), ASME Code Class 1, 2 and 3 components must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the ASME Code (Section Xl) to the extent practical within the limitations of design, geometry and materials of construction of the components. The regulations require that all inservice examinations and system pressure tests conducted during the first 10-year interval and subsequent intervals on ASME Code Class 1, 2, and 3 components must comply with the requirements in the latest edition and addenda of Section XI incorporated by reference in 10 CFR 50.55a(b) on the date 12 months prior to the start of the 10-year interval. The applicable edition of Section XI for PBAPS Units 2 and 3, during the current I0-year ISI interval is the 1980 Edition, as inclusive through to the Winter 1981 Addenda of the edition.

Section 50.55a(g)(6)(ii)(A)(*2*) requires all licensees to augment their reactor vessel examination by implementing once, as part of the ISI interval in effect on September 8, 1992, the examination requirements for reactor vessel shell welds specified in Item B1.10, Examination Category B-A, “Pressure Retaining Welds in Reactor Vessel, Table IWB-2500-1 to Section XI..." The section requires licensees to implement augmented examinations of essentially 100 percent of the RPV shell welds. ASME Code Category B1.10 covers requirements for examinations of RPV circumferential shell welds (Examination Item B1.11) and longitudinal shell welds (Examination Item B1.12). Section 50.55a(g)(6)(ii)(A)(*2*) defines "essentially 100-percent examination as covering 90 percent or more of the examination volume of each weld. The schedule for implementation of the augmented inspection is dependent upon the number of months remaining in the 10-year ISI interval that was in effect on September 8, 1992.

3.3 Basis for Relief

Section 10 CFR 50.55a(g)(6)(ii)(A)(*5*) allows licensees who are unable to completely satisfy the augmented RPV shell weld examination requirements to submit information to the Commission to support such a determination and to propose alternatives to the examination requirements that would provide an acceptable level of quality and safety in lieu of complying with the requirements.

Section 50.55a(a)(3)(i) indicates that alternatives to the requirement in 10 CFR 50.55a(g) are justified when the proposed alternative provides an acceptable level of quality and safety in lieu of complying with the requirements.

3.4 Proposed Alternatives

PECO proposes to use a probabilistic failure (risk) analysis as an alternative program to the augmented examination requirements of 10 CFR 50.55a(g)(6)(ii)(A)(2), and the ISI requirements of Section XI, and as the basis for justifying a permanent deferral of the required augmented volumetric examinations of the circumferential shell welds in the PBAPS RPVs. Although PECO did not specifically refer to the provisions in 10 CFR 50.55a(g)(6)(ii)(A)(*5*) or 10 CFR 50.55a(a)(3)(i) as the basis for submitting its relief request, the staff considers PECO's provisions to be submitted under the provisions of 10 CFR 50.55a(g)(6)(ii)(A)(*5*) and 10 CFR 50.55a(a)(3)(i); this is consistent with the guidelines of GL 98-05, which was issued on November 10, 1998, and summarized the staff's position on the relief request submitted in accordance with BWRVIP-05.

3.5 Evaluation

3.5.1 Evaluation of PECO's Probabilistic Fracture Mechanics Assessment

The plates in the PBAPS RPVs were welded by CB&I. In reviewing PECO's assessment, the staff confirmed that the chemistry factors, ΔRT_{ndt} values, margin terms, and RT_{ndt} values were calculated in accordance with the guidelines of Regulatory Guide 1.99, Revision 2, and that the copper and nickel contents listed for the circumferential welds were consistent with the values listed in the Combustion Engineering Owners Group (CEOG) Task Report CE-NPSD 1039, Revision 2. Table 3.5.1-1 in the Appendix to this SE illustrates that the RT_{ndt} values for the circumferential welds in the PBAPS RPVs are less than the Mean RT_{ndt} value (44.5 °F) for circumferential welds from the CB&I reference case. Since the RT_{ndt} values for the circumferential welds are bounded by the corresponding Mean RT_{ndt} value for the CB&I reference case, the staff concludes that PECO has provided sufficient assurance that the degree of projected embrittlement of the circumferential welds in the PBAPS Units 2 and 3, are also bounded by that assessed for the CEOG reference case. The staff, therefore, concludes that the conditional probabilities of failure for the circumferential welds in the PBAPS RPVs should be less than that calculated by the staff (2.0×10^{-7} per reactor-year) for the corresponding CB&I reference case. Based on this analysis, the staff concludes that the assessment of the circumferential welds in the PBAPS RPVs is consistent with the staff's analysis in SECY-98-219, and that PECO's alternative probabilistic fracture mechanics program provides a sufficient and acceptable basis for permanently deferring the volumetric examinations of the circumferential welds in the PBAPS Unit 2 and 3 RPVs.

3.5.2 Evaluation of PECO's Operational and Procedural Controls in Support of the PECO Probabilistic Fracture Mechanics Assessments

During review of the BWRVIP-05 report, "BWR Reactor Pressure Vessel Shell Weld Inspection Recommendations," the staff identified non-design basis events which should have been considered in the BWRVIP-05 report. In particular, the potential for and consequences of cold over-pressure transients should be considered. The licensee has assessed the systems that could lead to a cold over-pressurization of the PBAPS Units 2 and 3 RPVs. These include the high pressure coolant injection (HPCI), reactor core isolation cooling (RCIC), control rod drive (CRD), and feedwater systems.

While not discussed in the licensee's submittal, the standby liquid control (SLC) system is an additional high pressure source. However, there are no automatic starts associated with the SLC system. The system is only initiated by manual operator action in accordance with the plant emergency operating procedures or during controlled test conditions. In the event of an inadvertent initiation of SLC during shutdown, the SLC injection rate of approximately 40 gpm would allow operators sufficient time to control reactor pressure.

The HPCI, RCIC, and reactor feedwater pumps are steam driven and do not function during cold shutdown and could not cause a low-temperature overpressure (LTOP) event. In all cases, the operators are trained in methods of controlling water level within specified limits in addition to responding to abnormal water level conditions during shutdown. The licensee stated that procedures are in place for monitoring and controlling reactor pressure, temperature and water inventory during all aspects of cold shutdown which would minimize the likelihood of an LTOP event from occurring. Plant-specific procedures and training have been established to provide guidance to the operators regarding compliance with the Technical Specification pressure-temperature limits.

On the basis of the evaluation of high pressure injection sources, operator training and established plant-specific procedures, the licensee concluded that sufficient guidance is in place to minimize the likelihood of an LTOP event. The staff concludes that a non-design basis cold over-pressure transient is unlikely to occur at PBAPS Units 2 and 3, and that the information provided by the licensee regarding the PBAPS Units 2 and 3 high pressure injection systems, operator training, and plant-specific procedures provides a sufficient basis to support approval of the alternative examination request.

4.0 CONCLUSIONS

The staff has determined that PECO has performed acceptable alternative probabilistic fracture mechanics assessments of circumferential welds in the PBAPS Units 2 and 3 RPVs. The staff has also determined that PECO's operational and procedural controls provide sufficient assurance that it is unlikely that a non-design basis cold over-pressure transient will occur at PBAPS Units 2 and 3, and that the PECO's information regarding the PBAPS Units 2 and 3 high pressure injection systems, operator training, and plant-specific procedures provide a sufficient basis to support approval of the alternative examination request. With respect to the alternative examination programs proposed by PECO, the staff concludes that the probabilistic fracture mechanics assessments of circumferential welds in the PBAPS Unit 2 and 3 RPVs, when taken in conjunction with PECO's operational and procedural controls to prevent LTOP events, provide an acceptable level of quality and safety in lieu of actually performing the

required volumetric inspections of the circumferential welds themselves, as required by 10 CFR 50.55a(g)(6)(ii)(A) and by Section XI of the ASME Code. The staff, therefore, concludes that the alternative programs provide an acceptable level of quality, safety, and are consistent with the provisions of 10 CFR 50.55a(a)(3)(i) and 50.55a(g)(6)(ii)(A)(5), and are acceptable by law, and that PECO may defer conducting volumetric examinations of the circumferential welds in the PBAPS Units 2 and 3 RPVs for the remaining time in the current 40-year operating terms for the units.

Appendix: Table 3.5.1-1, “Probabilistic Fracture Mechanics Assessments for Circumferential Welds in the Peach Bottom (PBAPS) Units 2 and 3 Reactor Pressure Vessels”

Principal Contributors: J. Medoff
A. Cubbage

Date: June 15, 2000

Appendix

Table 3.5.1-1 Probabilistic Fracture Mechanics Assessments for Circumferential Welds in the Peach Bottom (PBAPS) Units 2 and 3 Reactor Pressure Vessels

Parameter	CB&I Probabilistic Fracture Mechanics Reference Case Criteria [1]	Probabilistic Fracture Mechanics Assessments for PBAPS Unit 2 [2]		Probabilistic Fracture Mechanics Assessments for PBAPS Unit 3 [2]	
		NRC Calculation	PECO Calculation	NRC Calculation	PECO Calculation
Neutron Fluence (n/cm^2)	5.1×10^{18}	8.8×10^{17}	8.8×10^{17}	7.9×10^{17}	7.9×10^{17}
Initial RT_{NDT} (°F)	-65	-32.0	-32.0	-50.0	-50.0
Chemistry Factor	134.1	76.4	76.4	136.9	136.9
Copper Content (Wt.-%)	0.100	0.056	0.056	0.102	0.102
Nickel Content (Wt.-%)	0.990	0.960	0.960	0.942	0.942
ΔRT_{NDT} (°F)	109.5	29.9	24.8	50.8	42.2
Margin Term (°F)	56.0	29.9	24.8	50.8	42.2
Mean Adjusted Reference Temperature (°F)	44.5	-2.1	-7.2	0.8	-7.8
Upper Bound Adjusted Reference Temperature (°F)	100.5	27.8	17.6	51.6	34.4

Notes:

1. The evaluation criteria listed here are for the Chicago Bridge and Iron Works reference case for circumferential RPV welds, as copied from Table 2.6-4 of the staff's final safety evaluation on Topical Report BWRVIP-05, dated June 28, 1998. These criteria will be used by the staff as the licensing basis for permanently deferring the volumetric examinations of the circumferential welds in the PBAPS RPVs.

2. The adjusted reference temperatures calculated by the staff for the PBAPS Units 2 and 3 RPVs were slightly more conservative from those calculated by PECO for the RPVs. The values calculated by the staff are consistent with the methodology for calculating adjusted reference temperatures in Regulatory Guide 1.99, Revision 2 (May 1988). The values calculated by the staff will be used as the licensing basis for permanently deferring the volumetric examinations of the circumferential welds in the PBAPS RPVs.

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