

June 30, 2010

Mr. Ashok Bhatnagar  
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SUBJECT: WATTS BAR NUCLEAR PLANT, UNIT 2 – SAFETY EVALUATION  
REGARDING GENERIC LETTER AND BULLETINS RELATED TO REACTOR  
PRESSURE VESSEL HEAD INSPECTIONS (TAC NOS. MD6709, MD6710,  
AND MD6711)

Dear Mr. Bhatnagar:

By letter dated September 7, 2007 (Agencywide Document and Access Management System (ADAMS) Accession No. ML072570676) that referenced the U.S. Nuclear Regulatory Commission (NRC) Order dated February 20, 2004 (ML040220181) and as supplemented by letter dated April 1, 2010 (ADAMS Accession No. ML100950044), the Tennessee Valley Authority (TVA) submitted responses to Generic Letter 1997-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," and Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs;" for Watts Bar Nuclear Plant (WBN), Unit 2.

The NRC staff has reviewed TVA's response. Enclosed is the NRC staff's safety evaluation. This completes the staff's efforts for TAC Nos. MD6709, MD6710, and MD6711, for WBN Unit 2.

Sincerely,

**/RA/**

Stephen J. Campbell, Chief  
Watts Bar Special Projects Branch  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-391

Enclosure: As stated

cc: Distribution via Listserv

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SAFETY EVALUATION BY THE  
OFFICE OF NUCLEAR REACTOR REGULATION REGARDING GENERIC LETTER AND  
BULLETINS RELATED TO REACTOR PRESSURE VESSEL HEAD INSPECTIONS  
TENNESSEE VALLEY AUTHORITY  
WATTS BAR NUCLEAR PLANT, UNIT 2  
DOCKET NO. 50-391

1.0 INTRODUCTION

By letter dated September 7, 2007 (Agencywide Document and Access Management System (ADAMS) Accession No. ML072570676) that referenced the U.S. Nuclear Regulatory Commission (NRC) Order dated February 20, 2004 (ADAMS Accession No. ML040220181) and as supplemented by letter dated April 1, 2010 (ADAMS Accession No. ML100950044), the Tennessee Valley Authority (TVA) submitted responses to Generic Letter (GL) 1997-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," Bulletin (BL) 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," BL 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary [RCPB] Integrity," and BL 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs," for Watts Bar Nuclear Plant (WBN), Unit 2.

2.0 REGULATORY EVALUATION

The general design criteria (GDC) establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems and components important to safety. The applicable GDC for GL 1997-01, BL 2001-01, BL 2002-01, and BL 2002-02 include GDC 14, "Reactor coolant pressure boundary," GDC 31, "Fracture prevention of reactor coolant pressure boundary," and GDC 32, "Inspection of reactor coolant pressure boundary." GDC 14 specifies that the RCPB shall be designed, fabricated, erected, and tested so as to have an extremely low probability of abnormal leakage, of rapidly propagating failure, and of gross rupture. GDC 31 specifies that (1) the boundary behaves in a nonbrittle manner, and (2) the probability of rapidly propagating fracture of the RCPB is minimized. GDC 32 specifies that components which are part of the RCPB shall be designed to permit (1) periodic inspection and testing of important areas and features to assess their structural and leaktight integrity, and (2) an appropriate material surveillance program for the reactor pressure vessel (RPV).

NRC regulations in Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.55a state that American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 1 components, which include the RCPB, must meet the requirements of ASME Code, Section XI. ASME Code, Section XI provides examination requirements that include visual

examinations (VT-2) during system leakage testing of all pressure-retaining components of the RCPB and reference IWB-3522 for acceptance standards. IWB-3522.1 specifies that conditions requiring correction include the detection of leakage from insulated components and discoloration or accumulated residues on the surfaces of components, insulation, or floor areas that may be evidence of borated water leakage, with leakage defined as the through-wall leakage that penetrates the pressure-retaining membrane. Therefore, 10 CFR 50.55a, by reference to the ASME Code, does not permit through-wall degradation of the RPV head penetrations.

Section 50.55a(g)(6)(ii)(D) of 10 CFR, "Reactor vessel head inspections," states the following:

(1) All licensees of pressurized water reactors shall augment their inservice inspection program with ASME Code Case N-729-1 subject to the conditions specified in paragraphs (g)(6)(ii)(D)(2) through (6) of this section. Licensees of existing operating reactors as of September 10, 2008 shall implement their augmented inservice inspection program by December 31, 2008. Once a licensee implements this requirement, the First Revised NRC Order EA-03-009 no longer applies to that licensee and shall be deemed to be withdrawn.

(2) Note 9 of ASME Code Case N-729-1 shall not be implemented.

(3) Instead of the specified 'examination method' requirements for volumetric and surface examinations in Note 6 of Table 1 of Code Case N-729-1, the licensee shall perform volumetric and/or surface examination of essentially 100 percent of the required volume or equivalent surfaces of the nozzle tube, as identified by Figure 2 of ASME Code Case N-729-1. A demonstrated volumetric or surface leak path assessment through all J-groove welds shall be performed. If a surface examination is being substituted for a volumetric examination on a portion of a penetration nozzle that is below the toe of the J-groove weld [Point E on Figure 2 of ASME Code Case N-729-1], the surface examination shall be of the inside and outside wetted surface of the penetration nozzle not examined volumetrically.

(4) By September 1, 2009, ultrasonic examinations shall be performed using personnel, procedures and equipment that have been qualified by blind demonstration on representative mockups using a methodology that meets the conditions specified in (50.55a(g)(6)(ii)(D)(4)(i) through (50.55a(g)(6)(ii)(D)(4)(iv), instead of the qualification requirements of Paragraph-2500 of ASME Code Case N-729-1. References herein to Section XI, Appendix VIII shall be to the 2004 Edition with no Addenda of the ASME BPV [Boiler and Pressure Vessel] Code.

(i) The specimen set shall have an applicable thickness qualification range of +25 percent to -40 percent for nominal depth through-wall thickness. The specimen set shall include geometric and material conditions that normally require discrimination from primary water stress corrosion cracking (PWSCC) flaws.

(ii) The specimen set must have a minimum of ten (10) flaws which provide an acoustic response similar to PWSCC indications. All flaws must be greater than 10 percent of the nominal pipe wall thickness. A minimum of 20 percent of the total flaws must initiate from the inside surface and 20 percent from the outside surface. At least 20 percent of the flaws must be in the depth ranges of 10-30 percent through wall thickness and at least 20 percent within a depth range of 31-50 percent through wall thickness. At least 20 percent and no more than 60 percent of the flaws must be oriented axially.

(iii) Procedures shall identify the equipment and essential variables and settings used for the qualification, and are consistent with Subarticle VIII-2100 of Section XI, Appendix VIII. The procedure shall be requalified when an essential variable is changed outside the demonstration range as defined by Subarticle VIII-3130 of Section XI, Appendix VIII and as allowed by Articles VIII-4100, VIII-4200 and VIII-4300 of Section XI, Appendix VIII. Procedure qualification shall include the equivalent of at least three personnel performance demonstration test sets. Procedure qualification requires at least one successful personnel performance demonstration.

(iv) Personnel performance demonstration test acceptance criteria shall meet the personnel performance demonstration detection test acceptance criteria of Table VIII-S10-1 of Section XI, Appendix VIII, Supplement 10. Examination procedures, equipment, and personnel are qualified for depth sizing and length sizing when the RMS error, as defined by Subarticle VIII-3120 of Section XI, Appendix VIII, of the flaw depth measurements, as compared to the true flaw depths, do not exceed 1/8 inch (3 mm), and the root mean square (RMS) error of the flaw length measurements, as compared to the true flaw lengths, do not exceed 3/8 inch (10 mm), respectively.

(5) If flaws attributed to PWSCC have been identified, whether acceptable or not for continued service under Paragraphs -3130 or -3140 of ASME Code Case N-729-1, the re-inspection interval must be each refueling outage instead of the re-inspection intervals required by Table 1, Note (8) of ASME Code Case N-729-1.

(6) Appendix I of ASME Code Case N-729-1 shall not be implemented without prior NRC approval.

### 3.0 TECHNICAL EVALUATION

#### 3.1 GL 1997-01

On April 1, 1997 (ADAMS Accession No. ML031110036), the NRC issued GL 1997-01, "Degradation of Control Rod Drive Mechanism Nozzle and Other Vessel Closure Head Penetrations," to the industry. GL 1997-01 requested, in part, that addressees provide a description of the plans to inspect the vessel head penetration (VHP) nozzles at their respective pressurized-water reactor (PWR) designed plants. With respect to the issuance of GL 1997-01, the NRC staff required the addressees to submit an initial response within 30 days of issuance

informing the staff of the intent to comply with requested information and a followup response within 120 days of issuance containing the technical details to the staff's information requests.

The Westinghouse Owners Group (WOG), in coordination with the efforts of Nuclear Energy Institute (NEI) and other PWR Owner Groups (the Babcock and Wilcox Owners Group, and Combustion Engineering Owners Group, determined that it was appropriate for its members to develop a cooperative integrated inspection program in response to GL 1997-01. The WOG program was documented in two Topical Reports issued by the Westinghouse Electric Corporation (WEC), WCAP-14901, Revision 0, "Background and Methodology for Evaluation of Reactor Vessel Closure Head Penetration Integrity for the Westinghouse Owners Group," and WCAP-14902, Revision 0, "Background Material for Response to NRC Generic Letter 97-01: Reactor Vessel Closure Head Penetration Integrity for the Westinghouse Owners Group." The WOG submitted the integrated programs described in WCAP-14901 and WCAP-14902 to the NRC staff on July 25, 1997.

The NRC staff determined by letters dated April 30 (ADAMS Accession No. ML082401547) and July 30, 1997 (ADAMS Accession No. ML082401578), that TVA was a member of the WOG and a participant in the WOG's integrated program that was developed to address the staff's requests in GL 1997-01. In TVA letters dated April 30 and July 30, 1997, TVA also indicated that the information in WEC Topical Report WCAP-14901 was applicable with respect to the assessment of VHP nozzles at WBN Unit 1. The NRC staff reviewed the TVA responses to GL 1997-01, dated April 30 and July 30, 1997, and required further information to complete its review of TVA responses as they relate to the WOG's integrated program for assessing VHP nozzles at WOG member plants, and to the contents of Topical Report No. WCAP-14901. The NRC staff issued a request for additional information (RAI), dated September 25, 1998 (ADAMS Accession No. ML073240250).

On December 11, 1998 (ADAMS Accession No. ML031600715), NEI submitted a generic, integrated response to the RAIs regarding GL 1997-01 on behalf of the PWR-industry and the utility members in the owners groups. In the generic submittal, NEI informed the NRC staff that it normalized the susceptibility rankings for the industry. The generic response to the RAIs also provided sufficient information to answer the requests in the RAIs, and emphasized that the integrated program is an ongoing program that will be implemented in conjunction with the Electric Power Research Institute, the PWR Owners Groups, the participating utilities, and the Material Reliability Projects' Subcommittee on Alloy 600. By letter dated March 21, 1999, the NRC staff informed NEI that the integrated program was an acceptable approach for addressing the potential for PWSCC to occur in the VHPs of PWR-designed nuclear plants, and that licensees responding to the GL could refer to the integrated program as a basis for assessing the postulated occurrence of PWSCC in PWR-design VHPs.

On February 11, 1999 (ADAMS Accession No. ML082460108), TVA provided a response to the NRC staff's RAI of September 25, 1998. In TVA letter of February 11, 1999, TVA endorsed the NEI submittal of December 11, 1998, and indicated that TVA was a participant in the NEI/WOG integrated program. Since the additional voluntary volumetric inspections performed in 1999 confirmed that PWSCC was not an immediate safety concern with respect to the structural integrity of VHPs in domestic PWRs, and since the NRC staff approved the integrated program for implementation by letter dated November 4, 1999 (ADAMS Accession No. ML993210023),

the NRC staff concluded that the integrated program provided an acceptable basis for evaluating WBN Unit 1 VHPs and completed its efforts relative to WBN Unit 1 responses to GL 1997-01.

### 3.2 BL 2001-01

On August 3, 2001 (ADAMS Accession No. ML012080284), the NRC issued BL 2001-01 to the industry. BL 2001-01 requested that addressees provide information related to the structural integrity of the reactor pressure vessel head penetration (VHP) nozzles for their respective facilities. Requested information included the extent of VHP nozzle leakage and cracking that had been found to date; the inspections and repairs that had been undertaken to satisfy applicable regulatory requirements, and the basis for concluding that their plans for future inspections will ensure compliance with applicable regulatory requirements at their respective PWR plants. TVA was requested to provide a response to Item 1 of BL 2001-01 within 30 days of its issuance.

TVA provided a response for WBN Unit 1 by letter dated August 31, 2001 (ADAMS Accession No. ML012530184). By letter dated November 20, 2001 (ADAMS Accession No. ML013240662), the NRC staff found for WBN Unit 1 that TVA provided the requested information that there was reasonable assurance that the public health and safety will be maintained. The NRC staff reminded TVA to provide the information requested in Item 5 of the Bulletin within 30 days after plant restart following the next refueling outage. By letter dated April 22, 2002 (ADAMS Accession No. ML021160004), TVA provided the information for Item 5 for WBN Unit 1 for BL 2001-01 to the NRC staff.

### 3.3 BL 2002-01

On March 18, 2002 (ADAMS Accession No. ML020770497), the NRC staff issued BL 2002-01 to the industry. BL 2002-01 requested that addressees provide information related to the integrity of the RCPB, including the RPV head, and the extent to which inspections had been undertaken to satisfy applicable regulatory requirements. BL 2002-01 also required licensees to provide the basis for concluding that plants satisfy applicable regulatory requirements related to the structural integrity of the RCPB and future inspections will ensure continued compliance with applicable regulatory requirements. All addressees were requested to respond to the following:

Items 1.A through E within 15 days of BL 2002-01 issuance, or to provide a written response to the NRC in accordance with the provisions of 10 CFR 50.54(f) if they were unable to provide the information or could not meet the requested completion dates.

Within 30 days after plant restart following the next inspection of the RPV head to identify any degradation, all addressees were required to submit information specified by Items 2.A and 2.B.

Within 60 days of the date of BL 2002-01, all addressees were required to submit to the NRC the following information related to the remainder of the RCPB:

The basis for concluding that your boric acid inspection program is providing reasonable assurance of compliance with the applicable regulatory requirements discussed in Generic Letter 88-05 and this bulletin. If a documented basis does not exist, provide your plans, if any, for a review of your programs.

By letter dated April 2, 2002 (ADAMS Accession No. ML020950043), TVA provided the 15-day response for WBN Unit 1 regarding BL 2002-01. By letter dated May 20, 2002 (ADAMS Accession No. ML021400648), the NRC staff found that TVA supplied the requested information, and concluded that WBN Unit 1 did not appear to have conditions similar to those that led to the degradation at Davis-Besse.

By letter dated May 17, 2002 (ADAMS Accession No. ML021410474), TVA provided the 60-day response to BL 2002-01 for WBN Unit 1. In a letter dated November 21, 2002 (ADAMS Accession No. ML023250516), the NRC staff evaluated licensee 60-day responses to BL 2002-01 concerning the rest of the RCPB and concluded that most of the licensee 60-day responses lacked specificity. Therefore, the NRC staff could not complete its review of the boric acid corrosion control programs in light of the lessons learned from the Davis-Besse event. The information request in BL 2002-01 may not have been sufficiently focused, which, in part, may explain the lack of clarity in the licensee 60-day responses. The NRC staff's review of the licensee 60-day responses provided the basis to develop the RAI dated November 21, 2002. By letter dated January 24, 2003 (ADAMS Accession No. ML030290340), TVA provided the 60-day response RAI for WBN Unit 1 regarding BL 2002-01.

### 3.3 BL 2002-02

On August 9, 2002 (ADAMS Accession No. ML022200494), the NRC issued BL 2002-02. BL 2002-02 requested addressees to provide information related to their RPV head and VHP nozzle inspection programs for their respective facilities. The information was to include a summary discussion of inspection program plans to supplement their required visual inspections with nonvisual nondestructive examination methods, or justification for reliance on visual examinations as the primary method to detect degradation. Addressees were requested to respond to Item (1) of the BL 2002-02 within 30 days of its issuance, or within 15 days of its issuance, to provide an alternative course of action, including the basis for acceptability of the proposed action.

TVA's letter of September 11, 2002 (ADAMS Accession No. ML022590056), responded to Item (1) of BL 2002-02, indicating the plans to perform RPV head and VHP nozzle inspections at WBN Unit 1. The TVA response also indicated that WBN Unit 1 was in the category of plants considered to have low susceptibility to RPV head and VHP cracking, based on a susceptibility ranking of less than 8 effective degradation years (EDY).

By letter dated December 20, 2002 (ADAMS Accession No. ML023540355), the NRC staff reviewed the TVA response to Item (1) of BL 2002-02 for WBN Unit 1. The NRC staff found the TVA immediate inspection plan to perform a 100-percent bare-metal visual examination during the fall 2003 refueling outage for WBN Unit 1 to provide reasonable assurance of adequate protection of public health and safety.

### 3.4 NRC Order EA-03-009

On February 20, 2004 (ADAMS Accession No. ML040220181), the NRC issued "First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors." In paragraph IV.B of the Order, there are criteria that licensees use to assign the RPV head at their facility to the appropriate PWSCC



susceptibility category. The “Low” category is for plants with a calculated value of EDY less than 8 and no previous inspection findings requiring classification as High.

Paragraphs IV.C(5)(a) and IV.C(5)(b) state the following:

- (5) Inspections of the RPV head shall be performed as directed in paragraphs IV.C.(1), IV.C.(2), IV.C.(3) and IV.C.(4) using the following techniques:
  - (a) Bare metal visual examination of 100 percent of the RPV head surface (including 360° around each RPV head penetration nozzle). For RPV heads with the surface obscured by support structure interferences which are located at RPV head elevations downslope from the outermost RPV head penetration, a bare metal visual inspection of no less than 95 percent of the RPV head surface may be performed provided that the examination shall include those areas of the RPV head upslope and downslope from the support structure interference to identify any evidence of boron or corrosive product. Should any evidence of boron or corrosive product be identified, the licensee shall examine the RPV head surface under the support structure to ensure that the RPV head is not degraded.
  - (b) For each penetration, perform a nonvisual NDE [nondestructive examination] in accordance with either (i), (ii) or (iii):
    - (i) Ultrasonic testing of the RPV head penetration nozzle volume (i.e., nozzle base material) from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-1]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0 inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-2). In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low-alloy steel
    - (ii) Eddy current testing or dye penetrant testing of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a

horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches [see Figure IV-3]); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater (see Figure IV-4).

- (iii) A combination of (i) and (ii) to cover equivalent volumes, surfaces and leak paths of the RPV head penetration nozzle base material and J-groove weld as described in (i) and (ii). Substitution of a portion of a volumetric exam on a nozzle with a surface examination may be performed with the following requirements:
1. On nozzle material below the J-groove weld, both the outside diameter and inside diameter surfaces of the nozzle must be examined.
  2. On nozzle material above the J-groove weld, surface examination of the inside diameter surface of the nozzle is permitted provided a surface examination of the J-groove weld is also performed.

### 3.5 Section 50.55a(g)(6)(ii)(D) of 10 CFR

WBN Unit 1 followed the Order. In accordance with 10 CFR 50.55a(g)(6)(ii)(D), WBN Unit 1 implemented their augmented inservice inspection program by December 31, 2008. Since WBN Unit 1 implemented this requirement, the First Revised NRC Order EA-03-009 no longer applied to WBN Unit 1 and was deemed to be withdrawn for WBN Unit 1.

By letter dated September 7, 2007, as supplemented letter dated April 1, 2010, TVA committed to perform the first inspection for WBN Unit 2 according to the requirements of paragraphs IV.C(5)(a) and IV.C(5)(b) of the First Revised NRC Order EA-03-009 at the first refueling outage. Since EA-03-009 has been superseded by 10 CFR 50.55a(g)(6)(ii)(D)(2) through (6) and ASME Code Case N-729-1, Watts Bar Unit 2 will perform inspections during the first refueling outage according to 10 CFR 50.55a (g)(6)(ii)(D)(2) through (6) and ASME Code case N-729-1. Also, WBN Unit 2 will perform a baseline inspection prior to fuel load that consists of paragraph IV.C(5)(b) of the First revised Order EA-03-009. By letter dated January 29, 2008 (ADAMS Accession No. ML080320443), TVA also committed to submit a report to address the inspection program for WBN Unit 2 per the requirements of GL 1997-01.

The NRC staff has reviewed the above information for WBN Unit 2 and finds the response acceptable.

#### 4.0 CONCLUSION

The NRC staff finds TVA's responses to GL 1997-01, BL 2001-01, BL 2002-01, and BL 2002-02 for WBN Unit 2 acceptable, since TVA will perform a baseline inspection prior to fuel load and will perform the inspections meeting the requirements of 10 CFR 50.55a(g)(6)(ii)(D).

Principal Contributor: John G. Lamb/Balwant K. Singal

Date: June 30, 2010