Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

January 24, 2003

10 CFR 50.54(f)

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20005-0001

Gentlemen:

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| In the Matter of | ) | Docket No. 50-327 |
| Tennessee Valley Authority | ) | 50-328 |
| | | 50-390 |

SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2 AND WATTS BAR NUCLEAR PLANT (WBN) UNIT 1 - SIXTY-DAY RESPONSE RAI TO NRC BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY," DATED NOVEMBER 21, 2002 (TAC NOS. MB4578, MB4579, MB4591)

This letter provides TVA's 60-day response to the NRC's Request for Additional Information (RAI) concerning the subject bulletin for SQN and WBN. Enclosures 1 and 2 provide TVA's response to the requested information for SQN and WBN, respectively.

If you have any questions concerning this matter, please contact Terry Knuettel at (423) 751-6673.

Mark J. Burzynski
Mark J. Burzynski
Manager
Nuclear Licensing

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 24th day of January, 2003.

A095

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

# SIXTY-DAY RESPONSE TO RAI TO NRC BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

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This enclosure contains SQN's sixty-day response to NRC's Request for Additional Information (RAI) on the subject bulletin dated November 21, 2002. TVA's responses to the bulletin for SQN were dated April 2, 2002 (15-day letter) and May 17, 2002 (60-day letter).

## NRC REQUEST

1. ***Provide detailed information on, and the technical basis for, the inspection techniques, scope, extent of coverage, and frequency of inspections, personnel qualifications, and degree of insulation removal for examination of Alloy 600 pressure boundary material and dissimilar metal Alloy 82/182 welds and connections in the reactor coolant pressure boundary (RCPB). Include specific discussion of inspection of locations where reactor coolant leaks have the potential to come in contact with and degrade the subject material (e.g., reactor pressure vessel (RPV) bottom head).***

## RESPONSE

The technical bases for performance of most of the inspections of Alloy 600 pressure boundary material and dissimilar metal Alloy 82/182 welds and connections in the RCPB are ASME Section XI requirements. Exceptions to ASME Section XI requirements have only been taken when relief has specifically been granted by NRC. The technical basis for the inspections performed as a result of commitments made to Generic Letter (GL) 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants," or Bulletin (BL) 2002-01 and BL 2002-02 "Reactor Pressure Vessel Head (RV) and Vessel Head Penetration (VHP) Nozzle Inspection Programs," is based on industry experience and involve actions prudent to safe operation.

Alloy 600/82/182 materials which have the potential to be externally examined for evidence of leakage are located on the RPV and the pressurizer (PRZ). The RPV has Alloy 600 in the upper and lower head penetrations welded with 82/182 weld material, which includes four auxiliary nozzles (abandoned Upper Head Injection nozzles) and one head vent nozzle. The RPV also has two Alloy 600 O-Ring leakage monitoring tubes welded with 82/182 weld material. SQN does not have 82/182 welded safe-ends on its cold or hot leg nozzles. The PRZ only has safe-ends welded with 82/182 weld material and does not contain Alloy 600 base material. These safe-ends are located at the surge line nozzle, safety and relief valve nozzles, and spray piping nozzle.

SQN's current "Corrosion Control Program" including commitments made in response to the subject bulletin and BL 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs," requires performance of direct and remote visual (video enhanced) examinations of the Alloy 600 upper head penetrations. The existing mirror insulation is raised 3 to 6 inches depending on the inspection technique used. TVA's "Corrosion Control Program" uses three inspection techniques: bare metal visual (BMV), supplemental visual (as defined in MRP-75, "PWR Reactor Pressure Vessel Upper Head Penetrations Inspection Plan") and a direct visual of the outer periphery nozzles. SQN completed its first 100 percent BMV examination on Unit 2 during Refueling Outage (RFO) 11. A BMV examination is planned for the next Unit 1 RFO (RFO 12). Prior to performing the initial BMV inspection, SQN performed direct visual examinations of the outer periphery penetrations beginning with RFO 6 for both units and plans to continue to do so for those RFOs not using the BMV or supplementary visual techniques. In accordance with TVA's "Corrosion Control Program," SQN is required to perform the BMV during each ASME Section XI ISI interval. (Refer to Table A, [Enclosure 1, Attachment] for additional information.)

BMV examinations are performed by certified inspectors. Other visual examinations are presently performed by metallurgical engineers qualified under Engineering Qualification Cards which reference BL 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants," dated March 17, 1988.

The PRZ 82/182 safe-end welds have been visually examined once by the plant metallurgical engineers based on operating experiences regarding failures related to Alloy 600/82/182 materials and were found acceptable. This inspection was performed during the last RFOs for both units (RFO 11) and was performed in conjunction with ISI examination where mirror insulation was removed providing full access to the nozzle and the safe-end welds. As stated above, the metallurgical engineers are qualified under Engineering Qualification Card guidelines.

Presently, SQN has not performed examinations of the lower head penetrations other than those indirect visual examinations for leakage which are performed during each ASME Section XI Mode 3 pressure test with the insulation installed. TVA's "Corrosion Control Program" procedure was recently revised to require inspection of the RPV bottom head nozzles once per ISI interval.

ASME Program inspections are performed on RCPB bolted connections prior to and after each RFO, except those exempted by Relief Request ISPT-8, dated April 27, 1998. Joints included in this inspection are located in the RPV head flange area, PRZ manways, steam generator hot and cold leg manways, RCP main flange bolts, valve bonnets, seal water injection flanges and related instrumentation connections. These examinations are performed by visual examination (VT) VT-2 certified personnel.

The ASME pressure test is performed post-refueling outage in Mode 3 with the Reactor Coolant System (RCS) temperature above 500° degrees Fahrenheit (F) and pressure between 2220 and 2250 pounds per square inch gauge (psig) which inspects the entire RCPB for leakage including the PRZ and the keyway under the RPV. These VTs (VT-2) are performed by personnel certified by the TVA nondestructive examination (NDE) personnel qualification program or qualified under ASME Section XI Code Case N-546, "Alternative Requirements for

Qualification of VT-2 Examination Personnel Section XI, Division 1." Insulation is not normally removed for this inspection. If evidence of leakage is found, the inspection may require insulation removal to determine the origin of the leak and to evaluate any degradation. If material susceptible to boric acid corrosion is involved, insulation is removed to evaluate for degradation. Due to the location and configuration of SQN Alloy 600/82/182 material, it is unlikely that any bolted connections other than the RV head flange, PZR manway, or RV head vent piping flange would have a leak path. The RV head bolting and PRZ manway bolting are also required to be examined for service induced flaws, in accordance with the ISI Program. One-third of the RV bolting is examined in each ISI period, resulting in 100 percent examination during each ISI interval.

A formal inspection of the RV and upper head is performed each RFO with the insulation above the insulation support ring remaining installed, as part of the RV head disassembly. Any evidence of boric acid leakage is reported and evaluated in accordance with TVA's "Corrosion Control Program" procedure.

The above inspections are primarily due to ASME Section XI or GL 88-05 requirements, except that under insulation upper head penetration inspections will be performed as a result of commitments made in response to BL 2002-01 and BL 2002-02.

**NRC REQUEST**

2. **Provide the technical basis for determining whether or not insulation is removed to examine all locations where conditions exist that could cause high concentrations of boric acid on pressure boundary surfaces or locations that are susceptible to primary water stress corrosion cracking (Alloy 600 base metal and**

**dissimilar metal Alloy 82/182 welds). Identify the type of insulation for each component examined, as well as any limitations to removal of insulation. Also include in your response actions involving removal of insulation required by your procedures to identify the source of leakage when relevant conditions (e.g., rust stains, boric acid stains, or boric acid deposits) are found.**

**RESPONSE**

SQN has removable mirror insulation installed on its RCPB components. Portions of the upper head insulation of the RPV are removed each RFO around the flange area which allows access to the closure head flange, flange studs and nuts, and 10 percent of the head above the flange. The Control Road Drive Mechanism (CRDM) shroud contains the remainder of the upper head insulation. This insulation does not conform to the head contour and, therefore, will not normally impede any flow of boric acid down the contour of the head. The shroud can be raised to provide access to 100 percent of the head penetrations when a 100 percent BMV is performed. During RFOs when the BMV is not performed, the shroud is raised enough to visually examine the outer periphery penetrations or a supplementary visual is performed as defined in MRP-75.

The technical basis for the removal of insulation for more direct inspection of areas with susceptible materials, possibly affected by Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 600 base material and 182/82 welds, is industry experience, including EPRI-MRP recommendations. TVA procedure "Corrosion Control Program," Appendix D, "Technical Requirements for Boric Acid Corrosion Control" is the governing procedure used in the evaluation of boric acid leaks. This procedure requires the removal of insulation when necessary (e.g., material susceptible to boric acid is present) to find a leak and to evaluate corrosion damage. If the source of leakage is determined without the removal of insulation and the material under the insulation is not susceptible to boric acid corrosion, an evaluation may be performed to accept the quantity of leakage without requiring insulation removal.

The insulation on the RCS is mirror insulation made of stainless steel. If evidence of leakage is identified, then insulation would typically be removed starting from the point of discovery back to the point of origin when the point of origin is not readily identifiable. If the point of origin is known, then the pathway of leakage can be determined and insulation removed such that a determination can be completed and proper corrective actions employed. These corrective actions begin with removal of the boric acid found on the base metal and evaluation for degradation. Further, corrective actions may then include cleaning (e.g., removing boric acid deposits, etc.) up to and including material repair or replacement.

For inspections performed during ASME Section XI pressure tests, Subsection IWA-5242 is applicable and reads as follows:

IWA-5242 Insulated Components

a) For systems borated for the purpose of controlling reactivity, insulation shall be removed from pressure retaining bolted connections for visual examination VT-2. For other components, visual examination VT-2 may be conducted without the removal of insulation by examining the accessible and exposed surfaces and joints of the insulation. Essentially, vertical surfaces of insulation need only be examined at the lowest elevation where leakage may be detectable. Essentially, horizontal surfaces of insulation shall be examined at each insulation joint.

b) When examining insulated components, the examination of surrounding area (including floor areas or equipment surfaces located underneath the components) for evidence of leakage, or other areas to which such leakage may be channeled, shall be required.

c) Discoloration or residue on surfaces examined shall be given particular attention to detect evidence of boric acid accumulations from borated reactor coolant leakage.

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
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UNITS 1 AND 2

SIXTY-DAY RESPONSE TO RAI TO NRC BULLETIN 2002-01,
"REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

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NRC REQUEST

3. **Describe the technical basis for the extent and frequency of walkdowns and the method for evaluating the potential for leakage in inaccessible areas. In addition, describe the degree of inaccessibility, and identify any leakage detection systems that are being used to detect potential leakage from components in inaccessible areas.**

RESPONSE

The technical basis for the extent and frequency of walkdowns is based on industry experience and the specific requirement in the 1989 Edition of ASME Section XI to perform a system leakage test on the RCPB each RFO, after the RV has been reassembled and prior to returning the unit to power operation. This is the only ASME Section XI Code requirement for a system walkdown at or near operating conditions.

SQN performs a walkdown of the components inside the containment building, including the RCS, at the start of every RFO. The walkdown is performed to identify components that require maintenance. The walkdown is performed at this time in order to facilitate the planning and execution of the maintenance work and to minimize the impact to the plant outage schedule.

At the beginning of each RFO, part of the RCS leakage test required by ASME Section XI, Subsection IWB is performed. SQN implements ASME Code Case N-533 which allows ASME Code Class 1 bolted connections, which are insulated, to be examined in a depressurized mode when it is more convenient to remove the insulation and perform the examination. The use of Code Case N-533 at SQN was allowed through the approved ASME Section XI System Pressure Test Program Relief Request ISPT-07 (NRC letter dated April 27, 1998). As the plant returns to service, the remainder of the RCS system leakage test is performed in accordance with the rules of ASME Section XI. Also at this time, the area underneath the RPV is examined for evidence of leakage.

During normal operations, the RCS is not accessible for walkdowns due to high radiation. Radiation monitors, temperature detectors, humidity monitors, sump level instrumentation, and water quality sample locations provide input to plant instruments and give indications of any plant leakage during normal operation. After a thorough review of the information provided through these instruments, decisions are made as to the appropriate actions. If the indication leads to the determination of the possibility of RCS leakage, then actions are taken in accordance with plant Technical Specifications (TS). Following the conclusion that a leak exists inside containment, accessible areas of the RCPB will be inspected while minimizing personnel radiation exposure.

**NRC REQUEST**

**4. Describe the evaluation that would be conducted upon discovery of leakage from mechanical joints (e.g., bolted connections) to demonstrate that continued operation with the observed leakage is acceptable. Also, describe the acceptance criteria that were established to make such a determination. Provide the technical basis used to establish the acceptance criteria. In addition,**

**a. if observed leakage is determined to be acceptable for continued operation, describe what inspection/monitoring actions are taken to trend/evaluate changes in leakage, or**

**b. if observed leakage is not determined to be acceptable, describe what corrective actions are taken to address the leakage.**

**RESPONSE**

In general, corrective action processes would be initiated with the identification of any evidence of boric acid leakage at mechanical joints within a given system. These corrective actions could consist of simple maintenance clean-up and tightening of the mechanical joint (to stop an active leak), may include a technical evaluation of the impact of the leakage, or include a full repair or replacement of the leaking component. The extent of corrective actions are based upon a case-by-case impact of the leakage. Industry experience, coupled with plant engineering/management judgment, will influence the corrective actions to be initiated. Any leakage in excess of the TS allowable RCS unidentified leakage (i.e., 1.0 gpm) would not be acceptable. The technical basis for this specific acceptance criteria is the SQN plant TS limit. However, corrective actions may be initiated at a much more conservative and lower leakage rate, depending upon the physical conditions and the severity of the impact of the leakage. An example of this type of response to identified boric acid leakage is SQN's use of a forced outage opportunity to investigate a slight increase in RCS leakage which resulted in the recently identified Unit 2 Reactor Vessel Level Indicating System compression fitting leak. As part of these corrective actions, TVA initiated a search for possible leakage, identified and repaired the leaking fitting, removed the boron residue, removed insulation to gain access for inspection of the adjacent RPV head area, and further removed boron deposits and evaluated the area on the RPV for any impact of degradation to the RPV.

In addition to these general corrective actions, SQN's ASME Section XI System Pressure Test Program also provides for a more specific process at bolted connections. The 1989 Edition of ASME Section XI, paragraph IWA-5250(a)(2), Corrective Action, contains a requirement to remove and perform a VT-3 examination of bolted connections where leakage has been identified during a system pressure test. SQN requested and was granted approval from the NRC in a letter dated April 27, 1998 to implement an alternative to this requirement [System Pressure Test Program Request for Relief ISPT-08]. ISPT-08 describes the evaluation that is conducted when leakage is identified at bolted connections. Typical conditions range from no quantifiable leakage (dry boron residue or moist boron residue with no water dripping) to a few drops per minute.

Acceptance of a known condition with leakage rates within TS limits is based on the particular material involved, the visual condition of the joint while still assembled, and experience with both that joint, similar joints, and the involved materials. Based on these particulars, examination of the bolting in the joint may be performed in the near term, deferred (e.g., for either a few weeks or until the next scheduled ISI examination), or not performed. The decision not to further inspect the bolting requires a solid basis that: (1) no potential for ongoing degradation exists [all material involved essentially is impervious to borated water corrosion], or (2) safety related equipment is not affected. Reinspection requirements are established on a case-by-case basis, considering the nature of the materials involved and the nature of the leakage.

With respect to the code required pressure test programs, corrective actions would be initiated with the identification of any boron leakage as described in the first paragraph. The evaluation of a boron leak may also include the involvement of plant senior management in determining whether to continue plant operation or place the plant in a safe mode to perform corrective maintenance. This evaluation would also include consideration of the known industry experience with a high degree of sensitivity to the impact of any boric acid leakage.

a. If observed leakage at a bolted connection is determined to be acceptable for continued operation, inspection and monitoring actions are taken as described above.

b. When observed leakage is determined not to be acceptable, as a minimum, the bolting most affected by the leak is removed and VT-1 examined for compliance with the requirements of ASME Section XI IWB-3141. If this examination reveals unacceptable damage to the bolting, the remaining bolting material in the joint is removed and VT-1 examined. Bolting material not judged acceptable by the VT-1 examination is replaced. In addition, other actions as necessary are taken to stop the leakage.

ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

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"REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

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**NRC REQUEST**

5. **Explain the capabilities of your program to detect the low levels of RCPB leakage that may result from through-wall cracking in the bottom RPV head incore instrumentation nozzles. Low levels of leakage may call into question reliance on visual detection techniques or installed leakage detection instrumentation, but has the potential for causing boric acid corrosion. The NRC has had a concern with the bottom RPV head incore instrumentation nozzles because of the high consequences associated with loss of integrity of the bottom head nozzles. Describe how your program would evaluate evidence of possible leakage in this instance. In addition, explain how your program addresses leakage that may impact components that are in the leak path.**

**RESPONSE**

The SQN TS for unidentified leakage (Surveillance Requirement 4.4.6.2.1) has a limit of 1.0 gpm. Normal leakage detection methods include (a) containment gas and particulate radiation monitors, (b) containment humidity monitors, and (c) containment temperature monitors. SQN TS surveillance requirement 4.4.6.2.1 is performed every 72 hours.

Unidentified leakage is typically well below the TS limit (i.e., 1.0 gpm) and system leakage is trended by the System Monitoring Program (SYSMON). Exceeding the SYSMON threshold (i.e., 0.1 gpm) results in further actions to determine the source of the leakage. This trend is evaluated on a biweekly basis. This trending supplements the normal leakage detection method which provides the capability to detect low levels of RCPB leakage.

RCPB leakage may result in increased levels of boric acid or ferric oxides in the containment environment. Since these products may be circulated by the ventilation system, it is possible that containment cooling equipment or radiation monitors will collect them. At SQN, the system engineering department performs inspections of the lower compartment coolers and the CRDM coolers for ferric oxide and boron on the cooling coils per the walkdown guidelines of NEDP-20, "Conduct of the Engineering Organization." The system engineering personnel report any findings for evaluation and corrective action. This inspection is performed each RFO. SQN's periodic instructions associated with filter paper replacement and pump swap-over instructions for containment building lower compartment air monitors have inspection requirements for boric acid. This instruction is performed every 25 days to determine if filter paper replacement is necessary due to the presence of boric acid or ferric oxides.

When the plant returns to service following a RFO, the RCS system leakage test is performed in accordance with ASME Section XI. That entry into the keyway, an examination of the area underneath the RPV for active evidence of leakage. This is a VT-2 performed by personnel certified by the TVA NDE personnel qualification program or qualified under ASME Section XI Code Case N-546. Insulation is not removed for this inspection. If evidence of leakage is found, plant procedures require that the source of the leak be identified and evaluated before unit startup. This requirement can result in the removal of insulation to positively locate the source of leakage and to allow evaluation of the leak.

An evaluation of leakage and the effect of leakage on components in the leak path is performed in accordance with TVA's "Corrosion Control Program" and Corrective Action Program procedures. This includes determining the leak path and evaluating any affected components for degradation. Acceptance of degradation is based on Code allowables or an engineering evaluation; otherwise, damaged components are repaired or replaced.

ENCLOSURE 1

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## NRC REQUEST

6. **Explain the capabilities of your program to detect the low levels of RCPB leakage that may result from through-wall cracking in certain components and configuration for other small diameter nozzles. Low levels of leakage may call into question reliance on visual detection techniques or installed leakage detection instrumentation, but has the potential for causing boric acid corrosion. Describe how your program would evaluate evidence of possible leakage in this instance. In addition, explain how your program addresses leakage that may impact components that are in the leak path.**

## RESPONSE

The SQN TS for unidentified leakage has a limit of 1.0 gpm. Normal leakage detection methods include (a) containment gas and particulate radiation monitors, (b) reactor building floor and equipment drain pocket sump level monitors, (c) containment humidity monitors, and (d) containment temperature monitors.

SQN TS 3.4.6.2 is performed every 72 hours. To keep from missing a performance, the shift performs the RCS water inventory surveillance every odd calendar day. Since the unidentified leakage is typically well below the limit, system leakage is trended under SYSMON. Threshold values of 0.1 gpm have been established for unidentified leakage at SQN. Exceeding the threshold results in further actions to attempt to determine the source of the leakage. Similarly, reactor building floor and equipment drain pocket sump level rate-of-rise is trended to detect small changes in inflow to the pocket sump, which may be an early indicator of increased RCPB leakage. The threshold value for Pocket Sump rate-of-rise is 0.1 gpm or a three-fold increase over normal values. Both of these trends are evaluated on a biweekly basis. This trending supplements the normal leakage detection method which provides the capability to detect low levels of RCPB leakage.

RCPB leakage may result in increased levels of boric acid or ferric oxides in the containment environment. Since some of these products may be circulated by the ventilation system, it is possible that containment cooling equipment or radiation monitors might collect deposits. At SQN, the system engineering department performs inspections on the lower compartment coolers and the CRDM coolers cooling coils for ferric oxide and boron per the walkdown guidelines of NEDP-20 and reports any positive findings for evaluation and identified corrective actions. This inspection is performed each RFO. SQN's periodic instructions associated with filter paper replacement and pump swap-over instructions for containment building lower compartment air monitors requires inspection of boric acid and, if detected, generates a problem evaluation report. This instruction is performed every 25 days for filter paper replacement.

During each RFO, an outage activity and PM requires a containment walkdown for evidence of leakage from RCPB and other critical components soon after shutdown. A general or "first hit" walkdown is performed first in accordance with SQN's Reactor Building Post-Shutdown Leakage Examination procedure. In accordance with NEDP-20, this is followed by a detailed walkdown of the following systems: Reactor Coolant, Sampling, Chemical and Volume Control, Safety Injection, Residual Heat Removal, and Waste Disposal (portions associated with the Reactor Coolant Drain Tank). Any leakage is documented and corrective action documents are initiated.

An evaluation of leakage and the effect of leakage on components in the leak path are performed in accordance with TVA's "Corrosion Control Program" and Corrective Action Program procedures. This includes determining the leak path and evaluating any affected components for degradation. Acceptance of degradation is based on Code allowables or an engineering evaluation; otherwise, damaged components are replaced.

ENCLOSURE 1

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NRC REQUEST

7. **Explain how any aspects of your program (e.g., insulation removal, inaccessible areas, low levels of leakage, evaluation of relevant conditions) make use of susceptibility models or consequence models.**

RESPONSE

Guidance from Westinghouse Report No. MED-PCE-12704, "Ten Year ISI Letter Report Transmittal," documents areas where potential degradation due to leakage could occur. These areas are based on industry experience and require removal of insulation to inspect. These areas include the RPV head penetrations, canopy seal welds, and instrument column flanges (conoseals) for evidence of leakage and boric acid crystal accumulation.

SQN presently has no susceptibility or consequence models that are used in determining methodologies regarding insulation removal, inaccessible areas, low levels of leakage, etc. However, an internal study performed by TVA in 1995 evaluated Alloy 600/182/82 components and concluded that there were no areas of high susceptibility where these alloys had been used in TVA plants. In addition, the EPRI-MRP Oconee Model has been considered when deciding to perform external partial and full head visual examinations in response to BL 2002-01. This model indicates the SQN units are ranked 68 and 69 in susceptibility and would not experience RVHP cracking similar to Oconee until approximately 195 effective full power years after March 1, 2001.

NRC REQUEST

8. **Provide a summary of recommendations made by your reactor vendor on visual inspections of nozzles with Alloy 600/82/182 material, actions you have taken or plan to take regarding vendor recommendations, and the basis for any recommendations that are not followed.**

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**RESPONSE**

TVA's RV vendor has not issued any generic guidance recommending inspection of Alloy 600/82/182 material. Westinghouse has provided guidance in Westinghouse Report No. MED-PCE-12704 regarding outer periphery penetrations and other areas with Alloy 600/82/182 materials to be looked at during shutdown for evidence of degradation or leakage. Additionally, WCAP-13006, "Alloy 600 PWSCC Assessments of Sequoyah 1 and 2 Reactor Vessel Bottom Head Penetrations," addresses the potential for PWSCC occurring in the RPV bottom head penetrations. This WCAP concludes that the low head penetrations have a low susceptibility for PWSCC and, therefore, have not been inspected at SQN. TVA's "Corrosion Control Program" procedure was recently revised to require inspection of the RPV bottom head nozzles once per 10 year ISI interval.

**NRC REQUEST**

9. **Provide the basis for concluding that the inspections and evaluations described in your responses to the above questions comply with your plant Technical Specifications and the Title 10 of the Code of Federal Regulations, Section 50.55(a), which incorporate Section XI of the American Society of Mechanical Engineers (ASME) Code by reference. Specifically, address how your boric acid corrosion control program complies with ASME Section XI, paragraph IWA-5250 (b) on corrective actions. Include a description of the procedures used to implement the corrective actions.**

**RESPONSE**

TVA's procedure for Corrosion Control has a specific appendix for the Boric Acid Corrosion Control Program inspections and evaluations titled, "Technical Requirements for the Boric Acid Corrosion Control

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Program." The inspections required by the Boric Acid Corrosion Control Program implement the recommendations of GL 88-05. These program requirements meet the requirements of Title 10 of the Code of Federal Regulations in that the system components are inspected and controlled in accordance with Appendix B and in a manner to ensure their continued integrity and required level of quality.

Boric acid corrosion control program required examinations have no direct interaction with the plant TS associated ASME Section XI Code Subsection IWA-5000 program pressure test requirements; except that the repairs or replacements on the ASME Code Class piping and components due to the corrective actions associated with the boric acid program inspections are performed in accordance with Section XI. Additionally, the systems' Section XI VT-2 required examinations may be integrated and coordinated with the boric acid program examinations so as to not duplicate manpower efforts. The program procedure requires a "damage assessment" be made against established acceptance criteria. Identified leakage with the presence of boric acid corrosion wastage is evaluated for the need of corrective maintenance to stop and prevent further leakage, for repair or replacement of the component, or for further more rigorous analytical evaluation of the component's structural integrity. The guidelines and acceptance criteria for this evaluation process are defined in the corrosion control program procedure. If localized corrosion loss due to boric acid corrosion exceeds the established minimum wall thickness or the general wastage criteria, a corrective action document is required to be initiated in accordance with TVA's corrective action program.

The allowed general wastage criteria (where a design-based established minimum wall thickness is not established) are based upon the allowed mill tolerances on the nominal wall thicknesses for piping. The use of the 12.5 percent threshold value in the boric acid control program for scheduled pipe is greater than the 10 percent evaluation threshold for the ASME Section XI System Pressure Test Program, as shown in IWA-5250, but is in line with the allowed limits associated with the system piping design requirements that have already been established through TVA's general system design processes. In the cases where no established minimum wall thickness is known, and the identified and assessed wastage exceeds the general wastage criteria of the piping nominal wall thickness (i.e., 12.5 percent), the structural integrity of the component is further evaluated and/or the component is repaired as part of TVA's corrective action process. Repairs and replacements for ASME Code Class components resulting from these corrective actions are implemented under TVA's Section XI Program procedure for "Repairs and Replacements of ASME Section XI Components," which implements the IWA-4000 and IWA-7000 repair and replacement requirements.

In compliance with the requirements of 10 CFR 50.55(a) and as required by SQN plant TS, VT-2 examinations of systems (including components containing boric acid) are conducted in accordance with TVA's ASME Section XI System Pressure Test Program. Examinations are performed in accordance with the requirements of IWA-5000 of the applicable ASME Section XI program code of record, including the specific requirements shown in IWA-5250.

ASME Section XI, Subsection IWA-5250 reads as follows:

"IWA-5250 CORRECTIVE MEASURES

(a) The source of leakage detected during the conduct of a system pressure test shall be located and evaluated by the Owner for corrective measures as follows:

   (1) buried components with leakage losses in excess of limits acceptable for continued service shall be repaired or replaced;
   (2) if leakage occurs at a bolted connection, the bolting shall be removed, VT-3 visually examined for corrosion, and evaluated in accordance with IWA-3100;
   (3) repairs or replacements of components shall be performed in accordance with IWA-4000 or IWA-7000, respectively.

(b) If boric acid residues are detected on components, the leakage source and the areas of general corrosion shall be located. Components with local areas of general corrosion that reduce the wall thickness by more than 10 percent shall be evaluated to determine whether the component may be acceptable for continued service, or whether repair or replacement is required."

TVA's ASME Section XI System Pressure Test Program and SQN's site system-specific pressure test program procedures implement these requirements. If boric acid leakage through the pressure retaining boundary is identified by the VT-2 examination, it must be dealt with by removal and the base metal evaluated for the effects of corrosion. As part of the system pressure test programmatic process, the ASME Section XI required threshold of identified wastage to the piping component wall thickness in excess of 10 percent of the thickness is evaluated for further corrective action. This evaluation includes the consideration and use of the guidelines and acceptance criteria associated with the boric acid corrosion control program (i.e., the design-based established allowed 12.5 percent general wastage criteria). Any further appropriate corrective actions necessary to ensure structural integrity and operability of the components are initiated. Note that SQN has requested and was granted approval to implement an alternative to the requirements in IWA 5250(a)(2) to remove and examine bolting where leakage has been identified during the conduct of a system pressure test. This is discussed in Response Number 4 above, including evaluation of bolted connections with evidence of leakage.

**CONCLUSION SUMMARY STATEMENTS**

Based on evaluation of TVA's boric acid inspection program described above, TVA complies with the applicable regulatory requirements discussed in GL 88-05 and this bulletin. As stated in TVA's May 17, 2002 response to NRC Bulletin 02-01, TVA plans to perform an assessment of the BWC Program by the fall of 2003. This assessment will be used to evaluate the effectiveness of enhancements and corrective actions associated with the BWC Program in response to recent industry events.

ENCLOSURE 1
ATTACHMENT

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2

SIXTY-DAY RESPONSE TO RAI TO NRC BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

TABLE A

| Component | Inspection Techniques | Personnel Qualifications | Extent of Coverage | Frequency | Degree of Insulation Removal/Insulation Type | Corrective Action |
|---|---|---|---|---|---|---|
| Reactor Vessel - Bottom Head Penetrations | Visual, VT-2 | SNT-TC-1A or Code Case N-546 | 100% limited - insulation not removed | Each RFO performed as part of the RCS leakage test. | None /mirror | If evidence of leakage is found, insulation may require removal to determine the origin of the leak and to evaluate any degradation. |
| | Visual | Qualified Metallurgical Engineer | Best effort* | Each ISI interval. | Remove insulation panels to enable a "best effort"* exam May be aided with remote visual techniques. | Further evaluate if any evidence of leakage is identified. |
| Reactor Vessel Head | Visual | Qualified Metallurgical Engineer | Outer periphery approx. 21 penetrations | Each RFO when not performing BMV or supplementary. | CRDM/Insulation shroud raised 3" | Further evaluate if any evidence of leakage is identified. Per MRP-75, reclassify reactor to high susceptibility. |
| | Remote Visual, VT-2 | SNT-TC-1A | 100% BMV | Unit 1 RFO 12 Unit 2 RFO 11 Complete each ISI interval thereafter. | Raise approx. 5" /mirror | Further evaluate if any evidence of leakage is identified. Per MRP-75, reclassify reactor to high susceptibility. |
| | Supplementary Visual | Qualified Metallurgical | Exterior surface of | Every 2nd RFO when not | Best effort* visual aided with boroscope | Further evaluate if any evidence of leakage is identified. Per |

ENCLOSURE 1
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SIXTY-DAY RESPONSE TO RAI TO NRC BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

| Component | Inspection Techniques | Personnel Qualifications | Extent of Coverage | Frequency | Degree of Insulation Removal/Insulation Type | Corrective Action |
|---|---|---|---|---|---|---|
| | | Engineer | RPV head | performing a BMV. | | MRP-75, reclassify reactor to high susceptibility. |
| Reactor Vessel - Primary Coolant Safe-ends | Volumetric, UT and Surface, PT | SNT-TC-1A | 100% | Each ISI interval | 100% of weld /mirror | Repair unacceptable indications as required by ASME Code. Note: This is stainless steel at SQN. |
| Pressurizer Safe-ends<br>- safety valve nozzle<br>- relief valve nozzle<br>- spray nozzle<br>- surge nozzle | Visual | Qualified Metallurgical Engineer | 100% | Each ISI interval | 100% of weld /mirror | Further evaluate if any evidence of leakage is identified. |

* "Best effort" is defined by the physical circumstances including consideration for access to remove the insulation completely, viewing the component surface at the correct angle, the use of visual examination assist devices, and the use of optimum practical lighting.

**ENCLOSURE 2**

**TENNESSEE VALLEY AUTHORITY**
**WATTS BAR NUCLEAR PLANT (WBN)**
**UNIT 1**

**SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"**

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This enclosure contains WBN's sixty-day response to NRC's Request for Additional Information (RAI) concerning the subject bulletin dated November 21, 2002. TVA's responses to the bulletin for WBN were dated April 2, 2002 (15-day letter) and May 17, 2002 (60-day letter).

**NRC REQUEST**

***1. Provide detailed information on, and the technical basis for, the inspection techniques, scope, extent of coverage, and frequency of inspections, personnel qualifications, and degree of insulation removal for examination of Alloy 600 pressure boundary material and dissimilar metal Alloy 82/182 welds and connections in the reactor coolant pressure boundary (RCPB). Include specific discussion of inspection of locations where reactor coolant leaks have the potential to come in contact with and degrade the subject material (e.g., reactor pressure vessel (RPV) bottom head).***

**RESPONSE**

The technical bases for performance of most of the inspections of Alloy 600 pressure boundary material and dissimilar metal Alloy 82/182 welds and connections in the RCPB are American Society of Mechanical Engineers (ASME) Section XI requirements. Exceptions to ASME Section XI requirements have only been taken when relief has specifically been granted by NRC. The technical basis for the inspections performed as a result of commitments made to Generic Letter (GL) 88-05, "Boric Acid Corrosion of Carbon Steel Reactor Pressure Boundary Components in PWR Plants," or Bulletin (BL) 2002-01 and 2002-02 "Reactor Pressure Vessel Head (RV) and Vessel Head Penetration (VHP) Nozzle Inspection Programs," is based on industry experience and involves actions prudent to safe operation.

Alloy 600/82/182 materials which have the potential to be externally inspected for evidence of leakage at WBN are located on the RV and the pressurizer (PZR). The RV has Alloy 600 upper and lower head penetrations and Alloy 82/182 safe-end welds to the RV hot and cold leg nozzles. The RV upper head also includes four auxiliary nozzles which are a combination of Alloy 82/182 welding material and Alloy 600 material. The PZR has only Alloy 82/182 safe-end welds to the surge line nozzle, safety and relief valve nozzles, and spray piping nozzle. The PRZ does not contain Alloy 600 base material. WBN's steam generators have no external Alloy 600 material or Alloy 82/182 welding material. The RV and PZR have mirror insulation.

The current program, including commitments made in responses to the subject bulletin and BL 2002-02, performs direct and remote (video enhanced) visual examinations of the Alloy 600 head penetrations under the upper head insulation. TVA's "Corrosion Control Program" uses three inspection techniques, remote visual (bare metal visual [BMV]), supplemental visual (as defined in Electrical Power Research Institute (EPRI) - Materials Reliability Project (MRP)-75, "PWR Reactor Pressure Vessel Upper Head Penetrations Inspection Plan") and a direct visual of the outer periphery nozzles. The remote visual examination, which is to be performed at Refueling Outage (RFO)-5 will be a 100 percent BMV examination and will be performed each ASME Section XI Inservice Inspection (ISI) interval thereafter. The direct visual will examine the outer periphery upper head penetrations. These examinations require the control rod drive mechanism (CRDM) ductwork and the mirror insulation to be raised to the maximum extent possible without disassembly (approximately five inches). (Refer to Table A [Attachment to this Enclosure] for additional information.)

Remote visual examinations are performed by visual testing (VT)-2 certified inspectors. Other visual examinations are presently performed by metallurgical engineers qualified under the Engineering Support Personnel Program which reference GL 88-05.

Formal inspections (Ultrasonic Testing [UT] and Penetrate Testing [PT]) are performed on the RV Alloy 82/182 safe-end welds discussed above as part of the ASME Section XI ISI interval. To date, the four RV hot leg safe-ends have been inspected and inspections are scheduled on the cold leg safe-ends prior to the end of the first ISI interval. The pressure boundary Alloy 82/182 welds on the RV that require examination per ASME Code will have been inspected by the end of the first ISI interval (refer to Table A).

The PZR safe-ends are visually examined when the insulation is removed for the ISI examination for the nozzle-to-vessel welds. The ISI examinations for the nozzle-to-vessel welds are performed during each ISI interval. The safety and relief valve nozzles, spray piping nozzle, and surge line nozzle are scheduled for examination before the end of the ISI interval. (Refer to Table A.)

Presently, WBN has not performed examinations of the lower head penetrations other than those indirect visual examinations which are performed during each ASME Section XI Mode 3 pressure test with the insulation installed. TVA's "Corrosion Control Program" procedure was recently revised to require a best effort visual inspection of the RPV bottom head nozzles once per ISI interval (refer to Table A).

An inspection is performed of bolted connections in the RCPB prior to entry into Mode 3 after each RFO, except as modified by NRC approved System Pressure Test Program Relief Requests ISPT-06 (NRC letter dated September 23, 1997) and ISPT-08 (NRC letter dated September 7, 2000). Joints included in this inspection are the RV head, PZR manway, steam generator hot and cold leg manways, reactor coolant pump (RCP) main flange bolts, valve bonnets, seal water injection flanges, and instrument connections. This is a VT performed by personnel certified to perform visual examination (VT-2). Any evidence of boric acid leakage (including residue and moist borated water) is reported and evaluated in accordance with TVA's "Corrosion Control Program" procedure.

A formal inspection of the RV and upper head is performed each RFO with the insulation above the insulation support ring remaining installed, as part of the RV head disassembly. Any evidence of boric acid leakage is reported and evaluated in accordance with TVA's "Corrosion Control Program" procedure.

The standard post-RFO pressure test performed in Mode 3 with the reactor coolant system (RCS) temperature greater than or equal to 500 degrees Fahrenheit (F) and pressure between 2220 and 2250 pounds per square inch guage (psig) looks at the entire RCPB including the PRZ and in the keyway under the RV for leakage. This is a VT-2 performed by personnel certified by the TVA nondestructive examination (NDE) personnel qualification program or qualified under ASME Section XI Code Case N-546, "Alternative Requirements for Qualification of VT-2 Examination Personnel Section XI, Division 1." Insulation is not removed for this inspection. If evidence of leakage is found, insulation may require removal to determine the origin of the leak and to evaluate any degradation. If material susceptible to boric acid corrosion is involved, insulation is removed to evaluate for degradation.

The RV head bolting and PRZ manway bolting are also required to be examined for service induced flaws, in accordance with the ISI Program. One-third of the RV bolting was examined in RFO-2, one-third in RFO-4, and the remainder is currently scheduled for RFO-6. The PRZ manway bolting is currently scheduled to be examined in place during RFO-5.

The above inspections are primarily due to ASME Section XI or GL 88-05, except that under insulation upper head penetration inspections will be performed as a result of commitments made in response to BL 2002-01 and BL 2002-02. Bottom head nozzle examinations are the result of industry experience.

**ENCLOSURE 2**

**TENNESSEE VALLEY AUTHORITY**
**WATTS BAR NUCLEAR PLANT (WBN)**
**UNIT 1**

**SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"**

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**NRC REQUEST**

**2. Provide the technical basis for determining whether or not insulation is removed to examine all locations where conditions exist that could cause high concentrations of boric acid on pressure boundary surfaces or locations that are susceptible to primary water stress corrosion cracking (Alloy 600 base metal and dissimilar metal Alloy 82/182 welds). Identify the type of insulation for each component examined, as well as any limitations to removal of insulation. Also include in your response actions involving removal of insulation required by your procedures to identify the source of leakage when relevant conditions (e.g., rust stains, boric acid stains, or boric acid deposits) are found.**

**RESPONSE**

The technical basis for the removal of insulation for more direct inspection of areas with susceptible materials, possibly affected by Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 600 base material and 182/82 welds, is from ASME Code (where applicable), and industry experience, including EPRI-MRP recommendations.

As stated in Response Number 1 above, the WBN RCPB has removable mirror insulation installed. This includes the two vessels which have material susceptible to PWSCC. These vessels are the RV and the PZR. Until BL 2002-01 was issued, WBN would only remove insulation on these vessels if there was evidence that boric acid residue existed behind the insulation or to perform scheduled ASME Section XI weld inspections.

For indications of boric acid discovered on any component, the Corrosion Control Program requires that insulation be removed as necessary to perform the required evaluation of boric acid found on plant components. Insulation is removed to perform the necessary inspections to determine the extent of boric acid leakage and any degradation to the underlying base metal. Insulation would typically be removed starting from the point of discovery back to the point of origin when the point of origin is not readily identifiable. If the point of origin is known, then the pathway of leakage can be determined and insulation removed such that a determination can be completed and proper corrective actions can be employed. These corrective actions may include removal of the boric acid found on the base metal and evaluation of the base metal. The corrective actions can include actions from accept-as-is, to cleaning, to a repair or replacement.

As stated in Response Number 1 above, WBN has committed to raise the RV head insulation to perform the visual inspections described. ASME Section XI examinations are performed on the RV Alloy 82/182 hot and cold leg safe-end welds as part of the ISI interval. The UT examination is performed from the inside diameter of the pipe as accessed through the RV. Insulation is removed at the RV hot and cold leg safe-ends to perform the PT examinations. In addition, the PZR safe-ends will be visually examined when the insulation is removed for the ISI examination of the nozzle-to-vessel welds. During the ASME Section XI RCS leakage test, which is performed each RFO, the insulation is not removed for the performance of the leakage test unless evidence indicates a leak has occurred. For any evidence of residue or leakage during these examinations and tests, the locations would be reported and evaluated in accordance with the Corrosion Control Program procedures.

The mirror insulation in the RCS is constructed of stainless steel and, in most areas, is not readily accessible for easy removal. Limitations on the removal of the insulation includes factors such as erecting scaffolding, higher radiation doses, and temporary laydown space. However, insulation removal problems are not used as a barrier to prevent the detection of boric acid leaks and the conduct of any subsequent corrective actions. Insulation has been removed, as noted in TVA's letter to the subject bulletin dated April 2, 2002 for the canopy seal weld leak which had indications of residue stains running down the penetration below the top of the head insulation.

Insulation on the bottom RV head is in the keyway which is considered a confined space as well as a high radiation area. The bottom head penetrations have been considered a low susceptibility area for PWSCC and, therefore, have not been inspected. Additional justification is provided in response to Question 8.

Insulation on the top RV head is removed from the flange up to the CRDM duct shroud for refueling purposes. The insulation on the CRDM shroud does not conform to the head contour and, therefore, will not normally impede any flow of boric acid down the contour of the head. The insulation within the shroud will be raised to allow the visual examinations described in Response 1 to be performed. This will be performed while the RV head is on the head stand. Insulation on the RV nozzle safe-end welds will be removed to perform the ASME Section XI required surface examination. Insulation on the top and bottom PRZ heads will be removed to perform the ASME Section XI examinations of the PRZ nozzle to vessel welds. The PRZ safe-end welds are exposed at this time to allow inspection.

TVA procedure "Corrosion Control Program," Appendix D, "Technical Requirements for the Borated Water Corrosion Program" is the governing procedure used in the evaluation of boric acid leaks. This procedure requires the removal of insulation when necessary to find the leak and to evaluate corrosion damage. If the source of the leakage has been determined without insulation removal and the material under the insulation is not susceptible to boric acid corrosion, then the evaluation may be performed without requiring insulation removal. In certain cases, all residue may not be removed. TVA has revised the procedure to require an engineering justification if boric acid residue is allowed to remain on susceptible material after discovery and evaluation, as committed to in response to BL 2002-01, dated May 17, 2002.

## NRC REQUEST

3. **Describe the technical basis for the extent and frequency of walkdowns and the method for evaluating the potential for leakage in inaccessible areas. In addition, describe the degree of inaccessibility, and identify any leakage detection systems that are being used to detect potential leakage from components in inaccessible areas.**

## RESPONSE

The technical basis for the extent and frequency of post refueling system pressure test is the 1989 Edition of ASME Section XI to perform a system leakage test on the RCPB each RFO, after the RV has been reassembled and prior to returning the unit to power operation. This is the only ASME Section XI Code requirement for a system walkdown at near operating conditions. Paragraph IWA-5241(b), Insulation Components, provides the requirements for leakage examinations in inaccessible areas. It states:

> "For components whose external surfaces are inaccessible for direct visual examination VT-2, only the examination of surrounding area (including floor areas or equipment surfaces located underneath the components) for evidence of leakage shall be required."

Examinations of inaccessible areas are accomplished by gaining access to as near the inaccessible area as is practical and examining pertinent areas for evidence of leakage. In actual practice, this ranges from checking for leakage at the point where embedded piping enters and exits walls, floors, or ceilings to an examination for evidence of leakage from the RV flanges, nozzles, and penetrations from the keyway under the vessel. The evaluation is accomplished in accordance with IWA-5250, IWB-3142, and the WBN Technical Specification (TS) for RCS leakage.

During normal plant operation, walkdowns of the majority of the RCPB piping and components are not possible due to high radiation and as low as reasonably achievable concerns. Walkdowns are normally performed at the beginning of RFOs. During forced or planned outages which put the reactor into modes involving cooldown and depressurization, walkdowns are performed at the beginning of the outage with the exception of an extremely short duration outage. In this case, the procedure allows the option for the walkdown to be canceled. The walkdown instruction provides guidance concerning examinations of inaccessible components. The guidance is similar to what is discussed above for IWA-5241(b). Evidence of the presence of boric acid is evaluated in accordance with TVA's "Corrosion Control Program."

Since WBN is on an 18-month fuel cycle, the system pressure test is performed nominally every 18 months, near the end of each RFO. Paragraph IWA-5221, System Leakage Test Boundary, defines the pressurization boundary for a system leakage test as ". . . the pressure retaining components within the system boundary containing pressurized reactor coolant under the plant mode of normal reactor startup." The only portions of RCS that are not pressurized under normal reactor startup conditions are those portions contained between the two valves present when the Code Class changes from Code Class 1 to another class. Primarily, this consists of small portions of vent and drain piping. The most significant portion of piping not pressurized is the portion between the inboard and outboard Residual Heat Removal (RHR) letdown lines that supply suction to the RHR pumps during RHR shutdown cooling.

**ENCLOSURE 2**

**TENNESSEE VALLEY AUTHORITY**
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**UNIT 1**

**SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"**

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**NRC REQUEST**

**4. Describe the evaluation that would be conducted upon discovery of leakage from mechanical joints (e.g., bolted connections) to demonstrate that continued operation with the observed leakage is acceptable. Also, describe the acceptance criteria that were established to make such a determination. Provide the technical basis used to establish the acceptance criteria. In addition,**

   **a. if observed leakage is determined to be acceptable for continued operation, describe what inspection/monitoring actions are taken to trend/evaluate changes in leakage, or**

   **b. if observed leakage is not determined to be acceptable, describe what corrective actions are taken to address the leakage.**

**RESPONSE**

In general, corrective action processes would be initiated with the identification of any evidence of boric acid leakage at mechanical joints within a given system. These corrective actions could include simple maintenance clean-up and tightening of the mechanical joint (to stop an active leak), may include a technical evaluation of the impact of the leakage, or include a full repair or replacement of the leaking component. The degree of corrective actions is based upon the case-by-case impact of the leakage. Industry experience, coupled with plant engineering/management judgment, influence the corrective actions to be initiated. Any leakage in excess of the TS allowable RCS unidentified leakage (i.e., 1.0 gallon per minute [gpm]) would not be acceptable. The technical basis for this specific acceptance criteria is the WBN plant TS limit. However, corrective actions may be initiated at a lower leakage rate, depending upon the physical conditions and the severity of the impact of the leakage.

In addition to these general corrective actions, WBN's ASME Section XI System Pressure Test Program also provides for a more specific process at bolted connections. The 1989 Edition of ASME Section XI, paragraph IWA-5250(a)(2), *Corrective Action,* imposes a requirement to remove and VT-3 examine bolting in bolted connections where leakage has been identified during a system pressure test. WBN requested and was granted approval from the NRC in a letter dated September 23, 1997 to implement an alternative to this requirement Relief Request ISPT-03. ISPT-03 describes the evaluation conducted when leakage is identified at bolted connections.

Typical leaking conditions range from no quantifiable leakage (dry boron residue or moist boron residue with no water dripping) to a few drops per minute. Acceptance of the condition within TS limits is based on the particular material specifications involved, the visual condition of the joint while still made up, and experience with the joint, similar joints, and the involved materials. Based on these particulars, examination of the bolting in the joint may be performed in the near term, deferred (e.g., for either a few weeks or until the next scheduled ISI examination), or not performed. The decision not to perform the examination of the bolting requires a solid basis that no potential for ongoing degradation exists (all material involved essentially impervious to borated water corrosion). Reinspection requirements are established on a case-by-case basis, considering the nature of the materials involved and the nature of the leakage.

Evidence of leakage in bolted connections is documented by completing a form to request engineering evaluation of the identified leak. A leak that cannot be terminated is also documented in TVA's Corrective Action Program.

a. If observed leakage is determined to be acceptable for continued operation, inspection and monitoring actions are taken as described above.

b. When observed leakage is determined not to be acceptable, as a minimum, the bolting most affected by the leak is removed and VT-1 examined for compliance with the requirements of IWB-3141. If this examination reveals unacceptable damage to the bolting, the remaining bolting material in the joint is removed and VT-1 examined. Bolting material not judged acceptable by the VT-1 examination is replaced. In addition, other actions as necessary are taken to stop the leakage.

**NRC REQUEST**

5. **Explain the capabilities of your program to detect the low levels of RCPB leakage that may result from through-wall cracking in the bottom RPV head incore instrumentation nozzles. Low levels of leakage may call into question reliance on visual detection techniques or installed leakage detection instrumentation, but has the potential for causing boric acid corrosion. The NRC has had a concern with the bottom RPV head incore instrumentation nozzles because of the high consequences associated with loss of integrity of the bottom head nozzles. Describe how your program would evaluate evidence of possible leakage in this instance. In addition, explain how your program addresses leakage that may impact components that are in the leak path.**

**RESPONSE**

The WBN TS for unidentified leakage has a limit of 1.0 gpm. Normal leakage detection methods include (a) containment gas and particulate radiation monitors, (b) containment humidity monitors, and (c) containment temperature monitors.

System leakage is verified to be below the limit by the performance of a surveillance instruction once every 72 hours. Since the unidentified leakage is typically well below the limit, system leakage is trended under the System Monitoring Program (SYSMON). Threshold values of 0.1 gpm have been established for unidentified leakage. Exceeding the threshold results in further actions to attempt to determine the source of the leakage. This trend is evaluated on a biweekly basis. This trending supplements the normal leakage detection method which provides the capability to detect low levels of RCPB leakage.

RCPB leakage may result in increased levels of boric acid or ferric oxides in the containment environment. Since some of these products may be circulated by the ventilation system, it is possible that containment cooling equipment or radiation monitors could collect residue. The Preventive Maintenance (PM) procedures for the lower compartment coolers and the CRDM Coolers contain requirements to inspect the cooling coils for ferric oxide and boron and report any positive findings for evaluation and corrective action. This PM is performed each RFO. The PM procedures for containment radiation monitor filter replacement contain requirements for visual inspection of the used filter by Chemistry personnel for boron or rust. This PM is performed weekly.

When the plant returns to service following a RFO, the RCS system leakage test is performed in accordance with the rules of ASME Section XI. At this time, an entry is made into the keyway and the area underneath the RPV is examined for evidence of leakage. This is a visual examination (VT-2) performed by personnel certified by the TVA NDE personnel qualification program or qualified under ASME Section XI Code Case N-546. Insulation is not removed for this inspection. If evidence of leakage is found, plant procedures require that the source of the leak be identified and evaluated before unit startup. This requirement can result in the removal of insulation to positively locate the source of leakage and to allow evaluation of the leak.

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An evaluation of leakage and the effect of leakage on components in the leak path is performed in accordance with the procedures for Corrosion Control and the ISI programs. This includes determining the leak path and evaluating any affected components for degradation. Acceptance of degradation is based on Code allowables or an engineering evaluation; otherwise, damaged components are repaired or replaced.

NRC REQUEST

6. **Explain the capabilities of your program to detect the low levels of RCPB leakage that may result from through-wall cracking in certain components and configuration for other small diameter nozzles. Low levels of leakage may call into question reliance on visual detection techniques or installed leakage detection instrumentation, but has the potential for causing boric acid corrosion. Describe how your program would evaluate evidence of possible leakage in this instance. In addition, explain how your program addresses leakage that may impact components that are in the leak path.**

The WBN TS for unidentified leakage has a limit of 1.0 gpm. Normal leakage detection methods include (a) containment gas and particulate radiation monitors, (b) Reactor Building floor and equipment drain pocket sump level monitors, (c) containment humidity monitors, and (d) containment temperature monitors.

System leakage is verified to be below the limit by the performance of a surveillance instruction once every 72 hours. Since the unidentified leakage is typically well below the limit, system leakage is trended under SYSMON. Threshold values of 0.1 gpm have been established for identified and unidentified leakage. Exceeding the threshold results in further actions to attempt to determine the source of the leakage. Similarly, Reactor Building floor and equipment drain pocket sump level rate-of-rise is trended to detect small changes in inflow to the pocket sump, which may be an early indicator of increased RCPB leakage. The threshold value for pocket sump rate-of-rise is 0.1 gpm or a three-fold increase over normal values. Both of these trends are evaluated on a biweekly basis. This trending supplements the normal leakage detection method which provides the capability to detect low levels of RCPB leakage.

RCPB leakage may result in increased levels of boric acid or ferric oxides in the containment environment. Since some of these products may be circulated by the ventilation system, it is possible that containment cooling equipment or radiation monitors might collect them. The PM procedures for the lower compartment coolers and the CRDM coolers contain requirements to inspect the cooling coils for ferric oxide and boron and report any positive findings for evaluation and corrective action. This PM is performed each RFO. The preventive maintenance procedures for containment radiation monitor filter replacement contain requirements for visual inspection of the used filter by Chemistry personnel for boron or rust. This PM is performed weekly.

During each RFO, the technical instruction for the Reactor Building post-shutdown walkdown requires a containment walkdown for evidence of leakage from RCPB and other critical components soon after shutdown. A general or "first hit" walkdown is performed, followed by a detailed walkdown of the following systems: Reactor Coolant, Sampling, Chemical and Volume Control, Safety Injection, Residual Heat Removal, and Waste Disposal (portions associated with the Reactor Coolant Drain Tank). Any leakage is documented and corrective action are initiated.

An evaluation of leakage and the effect of leakage on components in the leak path is performed in accordance with the TVA "Corrosion Control Program." This includes determining the leak path and evaluating any affected components for degradation. Acceptance of degradation is based on Code allowables or an engineering evaluation; otherwise, damaged components are repaired or replaced.

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**NRC REQUEST**

**7. Explain how any aspects of your program (e.g., insulation removal, inaccessible areas, low levels of leakage, evaluation of relevant conditions) make use of susceptibility models or consequence models.**

**RESPONSE**

Until recently, WBN had not specifically used any susceptibility or consequence models when making a determination on whether to remove insulation, look in areas generally considered inaccessible, or in the evaluation of relevant conditions associated with Alloy 600 or 82/182 material. TVA performed an in-house study in 1995 that evaluated the components in the TVA PWRs. This study concluded that there were no areas of high susceptibility where Alloy 600/182/82 had been used in the TVA plants. Susceptibility and consequence models are relatively new tools used in the evaluation of the potential for PWSCC and, prior to the determination of circumferential cracking in RV head penetrations at Oconee, were not considered particularly useful. In addition, WBN considered the EPRI-MRP Oconee model when committing to perform external partial and full head visual examinations in response to BL 2002-01. This model indicates that WBN is ranked 63rd in susceptibility and would not experience RV head penetration cracking similar to Oconee until approximately 126.7 effective full power years after March 1, 2001 (EPRI MRP-48, "PWR Materials Reliability Program Response to NRC Bulletin 2002-01").

**NRC REQUEST**

**8. Provide a summary of recommendations made by your reactor vendor on visual inspections of nozzles with Alloy 600/82/182 material, actions you have taken or plan to take regarding vendor recommendations, and the basis for any recommendations that are not followed.**

**RESPONSE**

TVA's RV vendor has not issued any generic or plant specific guidance recommending inspection of Alloy 600/82/182 material for WBN. In 1993, Westinghouse recommended that the upper head insulation be raised and a visual inspection of the penetration/head interface be performed at TVA's Sequoyah Nuclear Plant (SQN). This recommendation was implemented at SQN and is performed each RFO. Thus far, WBN has not implemented a similar inspection due to plant similarity and the limited duration of plant operation. WBN, beginning with RFO-5, as committed in response to BL 2002-01, will perform a 100 percent full visual/video aided bare metal visual inspection of the upper head each ISI interval and a best effort direct visual each RFO which meets the Westinghouse recommendation to SQN.

Additionally, WCAP-13006, "Alloy 600 PWSCC Assessments of SQN 1 and 2 Reactor Vessel Bottom Head Penetrations," addresses the potential for PWSCC occurring in the RPV bottom head penetrations. This WCAP concludes that the low head penetrations have a low susceptibility for PWSCC and, therefore, have not been inspected at WBN. TVA's "Corrosion Control Program" procedure was recently revised to require inspection of the RPV bottom head nozzles once per ISI interval.

**NRC REQUEST**

9. **Provide the basis for concluding that the inspections and evaluations described in your responses to the above questions comply with your plant Technical Specifications and the Title 10 of the Code of Federal Regulations, Section 50.55(a), which incorporate Section XI of the American Society of Mechanical Engineers (ASME) Code by reference. Specifically, address how your boric acid corrosion control program complies with ASME Section XI, paragraph IWA-5250(b) on corrective actions. Include a description of the procedures used to implement the corrective actions.**

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

## RESPONSE

TVA's procedure for Corrosion Control has a specific appendix for the Boric Acid Corrosion Control Program inspections and evaluations. The inspections of the boric acid corrosion control program implement the recommendations of GL 88-05. The Corrosion Control Program meets the requirements of Title 10 of the Code of Federal Regulations (CFR) in that the system components are inspected and controlled in accordance with 10 CFR 50, Appendix B and in a manner to ensure their continued integrity and required level of quality. Boric acid corrosion control program required examinations have no direct interaction with the plant TS associated ASME Section XI Code Subsection IWA-5000 program pressure test requirements; except that the repairs or replacements on the ASME Code Class piping and components caused by the corrective actions associated with the boric acid program inspections are performed in accordance with Section XI, and that the systems' Section XI VT-2 required examinations may be integrated and coordinated with the boric acid program examinations so as to not duplicate manpower efforts.

The program procedure requires a "damage assessment" be made against established acceptance criteria. Identified leakage with the presence of boric acid corrosion wastage is evaluated for the need of corrective maintenance to stop and prevent further leakage, for repair or replacement of the component, or for further more rigorous analytical evaluation of the component's structural integrity. The guidelines and acceptance criteria for this evaluation process is defined in the Corrosion Control Program procedure. If localized corrosion loss due to boric acid corrosion exceeds the established minimum wall thickness or the general wastage criteria, a corrective action document is required to be initiated in accordance with TVA's corrective action program.

The allowed general wastage criteria (where a design-based established minimum wall thickness is not established) is based upon the allowed mill tolerances on the nominal wall thickness for piping. The use of the 12.5 percent threshold value in the boric acid control program for scheduled pipe is greater than the 10 percent evaluation threshold for the ASME Section XI System Pressure Test Program, as shown in IWA-5250, but is in line with the allowed limits associated with the system piping design requirements that have already been established through TVA's general system design processes. In the cases where no established minimum wall thickness is known, and the identified and assessed wastage exceeds the general wastage criteria of the piping nominal wall thickness (i.e., 12.5 percent), the structural integrity of the component is further evaluated and/or the component is repaired as part of TVA's corrective action process. Repairs and replacements for ASME Code Class components resulting from these corrective actions are implemented under TVA's Section XI Program procedure for "Repairs and Replacements of ASME Section XI Components," which implements the IWA-4000 and IWA-7000 repair and replacement requirements.

In compliance with the requirements shown in 10 CFR 50.55(a) and as required by WBN plant Technical Requirements Manual, VT-2 examinations of systems (including components containing boric acid) are conducted in accordance with TVA's ASME Section XI System Pressure Test. Examinations are performed in accordance with the requirements of IWA-5000 of the applicable ASME Section XI program code of record, including the specific requirements shown in IWA-5250.

ASME Section XI, Subsection IWA-5250 reads as follows:

"IWA-5250 CORRECTIVE MEASURES

(a) The source of leakage detected during the conduct of a system pressure test shall be located and evaluated by the Owner for corrective measures as follows:

(1) buried components with leakage losses in excess of limits acceptable for continued service shall be repaired or replaced;
(2) if leakage occurs at a bolted connection, the bolting shall be removed, VT-3 visually examined for corrosion, and evaluated in accordance with IWA-3100;
(3) repairs or replacements of components shall be performed in accordance with IWA-4000 or IWA-7000, respectively.

(b) If boric acid residues are detected on components, the leakage source and the areas of general corrosion shall be located. Components with local areas of general corrosion that reduce the wall thickness by more than 10 percent shall be evaluated to determine whether the component may be acceptable for continued service, or whether repair or replacement is required."

TVA's standard programs and processes for "ASME Section XI System Pressure Test Program," and WBN's site-specific system pressure test program procedure implement these requirements. If boric acid leakage through the pressure retaining boundary is identified by the VT-2 examination, it must be dealt with by removal and the base metal evaluated for the effects of corrosion. As part of the system pressure test programmatic process, the ASME Section XI required threshold of identified wastage to the piping component wall thickness in excess of 10 percent of the thickness is evaluated for further corrective action. This evaluation includes the consideration and use of the guidelines and acceptance criteria associated with the boric acid corrosion control program (i.e., the design-based established allowed 12.5 percent general wastage criteria). Any further corrective actions necessary to ensure structural integrity and operability of the components are initiated. Note that WBN has requested and was granted approval to implement an alternative to the requirements in IWA 5250(a)(2) to remove and examine bolting where leakage has been identified during the conduct of a system pressure test. This is discussed in Response 4, including evaluation of bolted connections with evidence of leakage.

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
WATTS BAR NUCLEAR PLANT (WBN)
UNIT 1

SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01,
"REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

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## CONCLUSION SUMMARY STATEMENTS

Based on evaluation of TVA's boric acid inspection program described above, TVA complies with the applicable regulatory requirements discussed in GL 88-05 and this bulletin. As stated in TVA's May 17, 2002 response to NRC Bulletin 2002-01, TVA plans to perform an assessment of the Boric Acid Control Program by the fall of 2003. This assessment will be used to evaluate the effectiveness of enhancements and corrective actions associated with the Boric Acid Control Program in response to recent industry events.

ENCLOSURE 2
ATTACHMENT

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2
AND WATTS BAR NUCLEAR PLANT (WBN) UNIT 1

SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

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TABLE A

| Component | Inspection Techniques | Personnel Qualifications | Extent of Coverage | Frequency | Degree of Insulation Removal/Insulation Type | Corrective Action |
|---|---|---|---|---|---|---|
| **Reactor Vessel** | | | | | | |
| Bottom Head Penetrations | Visual, VT-2 | SNT-TC-1A or Code Case N-546 | 100%, insulation not removed | Each RFO. | None for initial inspection /mirror | If evidence of leakage is found, insulation may require removal to determine the origin of the leak and to evaluate any degradation. |
| | Visual | Qualified Metallurgical Engineer | Best effort* | Each ISI interval. | Remove insulation panels to enable a "best effort" *exam. May be aided with remote visual techniques | Further evaluate if any evidence of leakage is identified. |
| Top Head Penetrations | Visual | Qualified Metallurgical Engineer | Outer periphery | Each RFO when not performing BMV or supplementary. | Raise approx. 5 inches /mirror | Further evaluate if any evidence of leakage is identified. Per MRP-75, reclassify reactor to high susceptibility . |
| | Remote Visual, VT-2 | SNT-TC-1A | 100% | RFO-5 and once each ISI 10 year interval | Raise approx. 5 inches /mirror | Further evaluate if any evidence of leakage is identified. Per MRP-75, reclassify reactor to |

ENCLOSURE 2
ATTACHMENT

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN) UNITS 1 AND 2
AND WATTS BAR NUCLEAR PLANT (WBN) UNIT 1

SIXTY-DAY RESPONSE TO NRC RAI TO BULLETIN 2002-01, "REACTOR PRESSURE VESSEL HEAD DEGRADATION AND REACTOR COOLANT PRESSURE BOUNDARY INTEGRITY"

| Component | Inspection Techniques | Personnel Qualifications | Extent of Coverage | Frequency | Degree of Insulation Removal/Insulation Type | Corrective Action |
|---|---|---|---|---|---|---|
| | | | | thereafter. | | high susceptibility. |
| | Supplementary Visual | Qualified Metallurgical Engineer | Exterior surface of RPV Head | Every 2nd RFO when not performing a BMV. | Best effort* visual aided with boroscope. | Further evaluate if any evidence of leakage is identified. Per MRP-75, reclassify reactor to high susceptibility. |
| Hot and Cold Leg Nozzle Safe-ends | Volumetric, UT and surface, PT | SNT-TC-1A | 100% | Each ISI interval. | 100% of weld /mirror | Repair unacceptable indications as required by ASME Code. |
| **Pressurizer** | | | | | | |
| Safe-end welds<br>- safety valve nozzle<br>- relief valve nozzle<br>- spray piping nozzle<br>- surge line nozzle | Visual | Qualified Metallurgical Engineer | 100% | Each ISI interval. | 100% of weld mirror | Further evaluate if any evidence of leakage is identified. |

* "Best effort" is defined by the physical circumstances including consideration for access to remove the insulation completely, viewing the component surface at the correct angle, the use of visual examination assist devices, and the use of optimum practical lighting.