TVA

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

September 11, 2002

10 CFR 50.54(f)

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

Gentlemen:

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 - THIRTY-DAY RESPONSE TO NRC BULLETIN 2002-02, "REACTOR PRESSURE VESSEL HEAD (RPV) AND VESSEL HEAD PENETRATION (VHP) NOZZLE INSPECTION PROGRAMS," DATED AUGUST 9, 2002

This letter provides TVA's 30-day response to the subject bulletin for SQN and WBN. NRC requested pressurized water reactor (PWR) licensees to provide information pertaining to changes made, if any, to their respective inspection plans for RPV head and VHP nozzles, and their justification for reliance on visual examinations if that is the licensee's primary method to detect degradation. Specifically, NRC requested PWR licensees to respond to Item (1)A or (1)B, depending on whether the licensee planned to supplement the inspection programs with non-visual nondestructive examinations methods (i.e., (1)A) or rely on visual inspections (i.e., (1)B).

Based on TVA's review of the requested information, TVA has determined that Item (1)B is applicable to both SQN and WBN. Enclosure 1 provides a description of TVA's inspection plans and provides the requested information for Item (1)B for both SQN and WBN. Enclosure 2 contains the regulatory commitments.

TVA is a member of the Materials Reliability Project (MRP) Alloy 600 Issue Task Group which has developed guidance for developing the 30-day response to NRC Bulletin 2002-02. Accordingly, TVA used MRP's guidance to respond to NRC's request for information.

A096

In accordance with the requested information for Item (2) contained in the subject bulletin, TVA plans to submit the required response to this item for SQN Units 1 and 2 and WBN Unit 1 within 30 days after each plant restart following the next inspection of the RPV head (including vessel head nozzles) to identify the presence of any degradation.

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

Sincerely,

Mark J. Burzynski

Mark J. Burzynski
Manager
Nuclear Licensing

Subscribed and sworn to before me
on this 11th day of September, 2002

Barbara J. Bearter
Notary Public

My Commission Expires January 25, 2003

Enclosures
cc (Enclosures):
NRC Resident Inspector
Sequoyah Nuclear Plant
2600 Igou Ferry Road
Soddy-Daisy, Tennessee 37379

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

cc: Continued on page 3

cc(Enclosures):

Mr. R. W. Hernan, Senior Project Manager
U.S. Nuclear Regulatory Commission
MS 08G9
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2739

Mr. L. Mark Padovan, Senior Project Manager
U.S. Nuclear Regulatory Commission
MS 08G9
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2739

Mr. Luis Reyes, Regional Administrator
U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303-8931

MJB:ETK:LYM
Enclosures
cc (Enclosures):

R. J. Adney, LP 6A-C
D. K. Baker, BR 3H-C
J. L. Beasley, OPS 4A-SQN
L. S. Bryant, MOB 2R-WBN
P. W. Harris, ADM 1V-WBN
D. L. Koehl, POB 2B-SQN
G. J. Laughlin, EQB 1A-WBN
J. E. Maddox, LP 6A-C
NSRB Support, LP 5M-C
R. T. Purcell, OPS 4A-SQN
J. A. Scalice, LP 6A-C
J. Semelsberger, EQB 2W-WBN
K. W. Singer, LP 6A-C
E. J. Vigluicci, ET 11A-K
Sequoyah Licensing Files, OPS 4C-SQN
Watts Bar Licensing Files, ADM 1L-WBN
EDMS, EB 5B-C (Re: L44 020816 001)

s:\nl\cl\nrc\bulletin\bl02-02\bl0202final2mrp.doc

ENCLOSURE 1

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

THIRTY-DAY RESPONSE TO NRC BULLETIN 2002-02, "REACTOR PRESSURE VESSEL HEAD (RPV) AND VESSEL HEAD PENETRATION (VHP) NOZZLE INSPECTION PROGRAMS"

Based on TVA's review of the requested information, TVA has determined that Item 1 (B) is applicable to both SQN and WBN. Accordingly, this enclosure provides SQN's and WBN's response on the subject bulletin for Item 1 (B).

1. Within 30 days of the date of this bulletin:

   B. PWR addressees who do not plan to supplement their inspection program with non-visual NDE methods are requested to provide a justification for continued reliance on visual examinations as the primary method to detect degradation (i.e., cracking, leakage, or wastage). In your justification, include a discussion that addresses the reliability and effectiveness of inspections to ensure that all regulatory and technical specification requirements are met during the operating cycle, and that addresses the six concerns identified in the Discussion Section of this bulletin. Also, include in your justification discussion of your basis for concluding that unacceptable vessel wastage will not occur between inspection cycles that rely on qualified visual inspections. You should provide all applicable data to support your understanding of the wastage phenomenon and wastage rates.

   TVA RESPONSE:

   TVA has evaluated the current status of SQN Units 1 and 2 and WBN Unit 1 with regard to accrued Effective Full Power Years (EFPY) and Effective Degradation Years (EDY) calculated in accordance with Materials Reliability Project (MRP)-48 (Equation 2.2), and the results are presented in the following Table:

Table

Unit	Estimated EFPYs at next refueling outage/Date	Head Temperature	Estimated EDYs at next refueling outage	Estimated EDYs at end-of-life (32 EFPY)
SQN U1	14.1 - spring 2003	547	1.48	3.4
SQN U2	14.8 - fall 2003	547	1.56	3.4
WBN U1	6.7 - fall 2003	557.3	1.11	5.3

As shown in the Table, both SQN and WBN are low susceptibility plants as defined by both the MRP Inspection Plan and NRC Bulletin 2002-02. Neither SQN or WBN will exceed the NRC established threshold (< 8.0 EDYs) of low susceptibility for the current licensed life of the plants, primarily due to the low operating head temperatures.

TVA responses to Bulletin 2002-01 (References 1 and 2) addressed the adequacy of visual inspection for compliance with the design and licensing basis of the plants. Those responses are still applicable. Additional technical justification for the adequacy of the inspections is provided in this response to Bulletin 2002-02.

TVA previously committed in References 1 and 2 to perform a 100 percent reactor vessel external head surface inspection to the extent possible using a remote camera for SQN Units 1 and 2 and WBN Unit 1. The inspection of SQN Unit 2 was completed in spring 2002 during Refueling Outage 11 as reported in Reference 15. The inspection of SQN Unit 1 is scheduled for spring 2003 during Refueling Outage 12 (Ref. 1) and Refueling Outage 5 (fall 2003) for WBN Unit 1 (Ref. 2).

The MRP Inspection Plan has been developed, reviewed, and approved by the pressurized water reactor (PWR) utilities (Ref. 3 and 4). It presents a technically credible inspection regimen that ensures, to a high degree of certainty, that leaks will be detected at an early stage long before wastage or circumferential cracking can challenge the structural integrity of the reactor coolant system (RCS) pressure boundary. Furthermore, implementation of the MRP Inspection Plan ensures continued compliance with the recommendations cited within NRC Bulletin 2002-02.

Therefore, TVA will revise its program for inspecting the RPV head and vessel head nozzles to implement the guidance in the MRP Inspection Plan by spring 2003 and plans to implement those requirements beginning with the conduct of the next planned bare metal visual (BMV) inspection (spring 2003 for SQN Unit 1 and fall 2003 for WBN Unit 1). (Note: A BMV inspection would not involve removal of any reactor vessel head paint). As previously stated, SQN Unit 2 BMV inspection was completed spring 2002 and met the inspection guidance contained in the MRP Inspection Plan.

Accordingly, TVA provides the following responses as justification for continued reliance on visual examinations as the primary method to detect degradation in the RPV head. Included in the responses is a discussion on the reliability and effectiveness of visual examinations as it relates to the six concerns cited in Bulletin 2002-02 and the basis for concluding that unacceptable wastage will not occur between refueling outages.

Concern No. 1:

Circumferential cracking of CRDM nozzles was identified by the presence of relatively small amounts of boric acid deposits. This finding increases the need for more effective visual and non-visual NDE inspection methods to detect the presence of degradation in CRDM nozzles before nozzle integrity is compromised.

Response:

Since the initial discovery of circumferential cracks above the J-groove weld in 2001, visual inspection techniques and approaches employed have been dramatically improved and a heightened sense of awareness exists for the range in size and appearance of visual indications that must be further investigated. Non-visual techniques similarly have and continue to evolve to more effectively examine the penetration tube and associated welds for evidence of cracks. Nothing in the recent events at Davis-Besse has altered the fundamental inspection capability requirements previously established as necessary to identify the presence of primary water stress corrosion cracking (PWSCC) and subsequent associated wastage. The effectiveness of inspection techniques continues to be evaluated and improved.

Electric Power Research Institute (EPRI) MRP has published detailed guidance for performing visual examinations of RPV heads (Ref. 5). A utility workshop was recently conducted to discuss this guidance and lessons learned from recent field experience (including Davis-Besse). RPV head BMV inspections at TVA will be performed and documented in accordance with written procedures and acceptance criteria that comply with the guidance of the MRP Inspection Plan. Evaluations and corrective actions will be rigorous and thoroughly documented.

In order for outside diameter (OD) circumferential cracks above the J-groove weld to initiate and grow, a leak path must first be established to the control rod drive mechanism (CRDM) annulus region from the inner wetted surface of the RPV head. If primary water does not leak to the annulus, the environment does not exist to cause circumferential OD cracking. Axial cracks in the CRDM nozzles or cracks in J-groove welds must first initiate and grow through-wall. Experience has shown that through-wall axial cracks result in observable leakage at the base of the penetration on the outer surface of the vessel, even with interference fits. Alloy 600 steam generator drain pipes at Shearon Harris (1988) and pressurizer instrument nozzles at Nogent 1 and Cattenom 2 (1989) were roll expanded but still developed leaks during operation (Ref. 6). Plant-specific top head gap analyses have been performed for a large number of plants, with nozzle initial interference fits ranging from 0 to 0.0034." These analyses have confirmed the presence of a physical leak path in essentially all nozzles under normal operating pressure and temperature conditions (Ref. 6).

The probability of detecting small CRDM leaks by visual inspections alone is high. EPRI has indicated that "*Visual inspections of the reactor coolant system pressure boundary have been proven to be an effective method for identifying leakage from primary water stress corrosion cracking (PWSCC) cracks in Alloy 600 base metal and Alloy 82/182 weld metal. Specifically, visual inspections have detected leaks in reactor pressure vessel (RPV) head CRDM nozzles, RPV head thermocouple nozzles, pressurizer heater sleeves, pressurizer instrument nozzles, hot leg instrument nozzles, steam generator drain lines, a RPV hot leg nozzle weld, a power operated relief valve (PORV) safe end and a pressurizer manway diaphragm plate.*" (Ref. 7). To date, no leaking CRDM nozzles have been discovered by non-visual non-destructive examination (NDE) except for the three nozzles at Davis-Besse where leakage would have been detected visually had there been good access for visual inspections and the head cleaned of pre-existing boric acid deposits from other sources (Ref. 6).

Finally, as described under Concern No. 3 below, detailed probabilistic fracture mechanics (PFM) analyses have been performed to demonstrate the effectiveness of visual inspections in protecting the CRDM nozzles against failure due to circumferential cracking (Ref. 8). Even though the above discussion illustrates that visual inspections performed in accordance with MRP recommendations have a high probability of detecting through-wall leakage, a very low probability of detection was assumed in the PFM analyses. The PFM analyses assume only a 60 percent probability that leakage is detected if a CRDM nozzle is leaking at the time a visual inspection is performed. Furthermore, if a nozzle has been inspected previously and leakage was missed, subsequent visual inspections are assumed to have only a 12 percent probability of detecting the leak. Even with these conservative probability of detection assumptions, the PFM analyses show that visual inspection every outage reduces the probability of a nozzle ejection to an acceptable level for plants with 18 or more EDY. Visual inspections of plants with fewer than 18 EDY in accordance with the MRP Inspection Plan will maintain the probability of nozzle ejection for these plants more than an order of magnitude lower than that for the greater than 18 EDY plants.

In summary, the industry has responded to the need to detect small amounts of leakage by increased visual inspection sensitivity, increased inspection frequencies, and improved inspection capabilities. Small amounts of leakage can be detected visually, and it has been shown that timely detection by visual examination ensures the structural integrity of the RPV head penetrations with respect to circumferential cracking.

Concern No. 2:

Cracking of 82/182 weld metal has been identified in CRDM nozzle J-groove welds for the first time and can precede cracking of the base metal. This finding raises concerns because examination of weld metal material is more difficult than base metal.

Response:

Cracks in the J-groove weld do not pose an increased risk regarding nozzle ejection as compared to penetration base metal cracks. J-groove weld cracks that initiate and grow through-wall leak the same as cracks in the penetration base metal. Therefore, weld cracks pose a similar risk as cracks in the base material and are equally detectable by visual examination. Although higher crack growth rates have been observed in laboratory testing of weld metal, the industry model of time-to-leakage includes plants that have had weld metal cracking as well as base metal cracking. The visual examination frequencies from the MRP Inspection Plan have been conservatively established based on the risk-informed analyses considering leakage due to both weld metal and base metal cracking.

Concern No. 3:

Through-wall circumferential cracking from the outside diameter of the CRDM nozzle has been identified for the first time. This raises concerns about the potential for failure of CRDM nozzles and control rod ejection, causing a LOCA.

Response:

PFM analyses using a Monte-Carlo simulation algorithm were performed to estimate the probability of nozzle failure and control rod ejection due to through-wall circumferential cracking (Ref. 8). The PFM analyses conservatively assume that, once a leak path has extended to the annulus region, an OD circumferential crack develops instantaneously, with a length encompassing 30 degrees of the nozzle circumference. Fracture mechanics crack growth calculations are then performed for this initially assumed crack, using material crack growth rate data from EPRI Report MRP-55 (Ref. 9). The parameters used in the PFM model were benchmarked against the most severe cracking found to date in the industry (Babcock & Wilcox (B&W) Plants) and produced results that are in agreement with experience to date. The analyses were used to determine probability of nozzle failure versus EFPY for various head operating temperatures. Analyses were then performed to estimate the effect of visual and non-visual NDE inspections of the plants in the most critical inspection category, using the conservative assumption discussed above (see Concern No. 1 response) for probability of leakage detection by visual inspection. These analyses demonstrate that performing visual inspections significantly reduces the probability of nozzle ejection, and that performing such examinations on a regular basis (in accordance with the inspection schedule prescribed in the MRP Inspection Plan) effectively maintains the probability of nozzle ejection at an acceptably low level indefinitely.

In the extremely unlikely event that nozzle failure and rod ejection were to occur due to an undetected circumferential crack, an acceptable margin of safety to the public would still be maintained (Ref. 10). The consequences of such an event are similar to that of a small-break loss-of-coolant-accident, which is a design-basis event. The probability of core damage given a nozzle failure (assuming that failure leads to ejection of the nozzle from the head) has been estimated to be 1×10^{-3}. The PFM analyses demonstrate that periodic visual inspections are capable of maintaining the probability of nozzle failure due to circumferential cracking well below 1×10^{-3}. Therefore, the PFM analyses demonstrate that the resulting incremental change in core damage frequency due to CRDM nozzle cracking can be maintained at less than 1×10^{-6} (i.e., 1×10^{-3} times 1×10^{-3} equals 1×10^{-6}) per plant year through a program of periodic visual examinations performed in accordance with the MRP Inspection Plan. This result is consistent with NRC Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decision on Plant-Specific Changes to the Current Licensing Basis," that defines an acceptable change in core damage frequency (1×10^{-6} per plant year) for changes in plant design parameters, technical specifications, etc.

Concern No. 4:

The environment in the CRDM housing/RPV head annulus will likely be more aggressive after any through-wall leakage because potentially highly concentrated borated primary water may become oxygenated. This raises concerns about the technical basis for current crack growth rate models.

Response:

The MRP panel of international experts on stress corrosion cracking (SCC) (including representatives from American Nuclear Laboratory/NRC Research), prior to the Davis-Besse incident, gave extensive consideration to the likely environment in the annulus between a leaking CRDM nozzle and the RPV head and subsequently revisited this issue following the incident (Ref. 9). When revisited, the relevant arguments remain valid as long as leak rates are less than 1 liter/hr. or 0.004 gallons per minute (gpm), which plant experience has shown to be the usual case. The conclusions were:

1. An oxygenated crevice environment is highly unlikely because:

   - Back diffusion of oxygen is too low compared to counterflow of escaping steam (two independent assessments based on molecular diffusion models were examined).
   - Oxygen consumption by the metal walls would further reduce its concentration.

- Presence of hydrogen from leaking water and diffusion through the upper head results in a reducing environment.
- Even if the concentration of hydrogen was depleted by local boiling, coupling between low alloy steel and Alloy 600 would keep the electrochemical potential low.
- Corrosion potential will be close to the nickel/nickel-oxide (Ni/NiO) equilibrium, resulting in PWSCC susceptibility similar to normal primary water.

2. The most likely crevice environments are either hydrogenated steam or PWR primary water within normal specifications and both would result in similar, (i.e. non-accelerated), susceptibility of the Alloy 600 penetration material to PWSCC.

3. If the boiling interface happens to be close to the topside of the J-weld, itself a low probability occurrence, concentration of PWR primary water solutes, lithium hydroxide and boric acid, can, in principle, occur. Of most concern here would be the accelerating effect of elevated pH on SCC, but calculations and experiments show that any changes are expected to be small, in part, because of the buffering effects of precipitates. A factor of 2x on the crack growth rate (CGR) conservatively covers possible acceleration of PWSCC, even up to a high-temperature pH of around 9.

   For larger leakage rates which could lead to local cooling of the head, concentration of boric acid, and development of a sizable wastage cavity adjacent to the penetration, the above arguments no longer directly apply. However, limited data (Berge et al., 1997) on SCC in concentrated boric acid solutions indicate that:

   - Alloy 600 is very resistant to transgranular SCC (material design basis).

- High levels of oxygen and chloride are necessary for intergranular cracking to occur at all.
- The effects are then worse at intermediate temperatures, suggesting that the mechanism is different from PWSCC.

The above considerations show that there is no basis for assuming that any post-leakage, crevice environment in the CRDM housing/RPV head annulus would be significantly more aggressive with regard to SCC of the Alloy 600 penetration material than normal PWR primary water, irrespective of the assumed leakage rate and/or annulus geometry. The current industry model (Ref. 9), which includes a factor of 2x on CGR to cover residual uncertainty in the composition of the annulus environment, remains valid.

Concern No. 5:

The presence of boron deposits or residue on the RPV head, due to leakage from mechanical joints, could mask pressure boundary leakage. This raises concerns that a through-wall crack may go undetected for years.

Response:

The experience at Davis-Besse has clearly demonstrated that effective visual inspection for leakage from CRDM nozzle and weld PWSCC requires unobstructed inspection access and that the head surface be free of pre-existing boric acid deposits. Accumulations of debris and boric acid deposits from other sources can interfere with a determination as to the presence or absence of boric acid deposits extruding from the tube-to-head annulus. Therefore, to effectively perform a visual examination of the RPV head outer surface for penetration leakage, such deposits and debris accumulations must be carefully inspected, removed, and the area re-inspected. Evaluation may show that it is necessary to perform a non-visual examination to establish the source of the leakage.

Accordingly, TVA conducts each inspection with a questioning attitude and any boric acid deposit on the vessel head will be evaluated to determine its source in accordance with existing industry guidance, supplemented by the most recent industry experience at the time of the inspection. These requirements are incorporated in the visual inspection guidance contained in the MRP Inspection Plan. Implementation of these requirements preclude the cited condition of a through-wall crack remaining undetected for years.

As stated earlier, TVA plans to perform a BMV examination for SQN Unit 1 during Refueling Outage 12 (spring 2003) and for WBN Unit 1 during Refueling Outage 5 (fall 2003). The SQN Unit 2 BMV was completed during Cycle 11 refueling outage (spring 2002) as reported in Reference 15. This inspection was accomplished by raising the insulation/CRDM duct work approximately 5 inches above the vessel head. A remote camera was then used to perform the visual examination. No indication of boron leakage was observed in the interface area that would be associated with PWSCC on the inside surfaces of the RPV head.

As reported in TVA's June 13, 2002, 30-Day Response to NRC Bulletin 2002-01 (Reference 15), heavy and light debris buildup was found around the uphill side of the RPV head penetrations. Debris was removed to allow inspection of the head for boron buildup. Also, as noted in TVA's report, the debris identified during inspection and which were left on the RPV head have not caused, and are not expected to cause, any degradation to the head.

References 1 and 2 contain a summary of reactor head inspections performed at SQN and WBN, respectively. In addition to the BMV noted above for SQN Unit 2, previous inspections at SQN have included: (1) overview visual examinations performed during the first 10-year ISI interval, and (2) best effort visual examinations performed each refueling outage since Cycle 7 of the outer two periphery rows of RPV penetrations. Inspections at WBN included limited visual examinations above the RPV head and the visible portion of the head at each refueling outage. No indication of boron leakage that would be associated with PWSCC on the inside surfaces of the RPV head have been identified.

Concern No. 6:

The causative conditions surrounding the degradation of the RPV head at Davis-Besse have not been definitively determined. The staff is unaware of any data applicable to the geometries of interest that support accurate predictions of corrosion mechanisms and rates.

Response:

The causes of the Davis-Besse degradation are sufficiently well known to avoid significant wastage. The root cause evaluation performed by the utility (Ref. 11) clearly identifies the root cause as PWSCC of CRDM nozzles followed by boric acid corrosion. The large extent of degradation has been attributed to failure of the utility to address evidence that had been accumulating over a five-year period of time (Figure 26 of Ref. 11).

The industry has provided utilities with guidance for vessel top head visual inspections to ensure that conditions approaching those which existed at Davis-Besse will not occur. Visual inspection guidelines have been provided (Ref. 5), and a workshop was conducted to thoroughly review industry experience, regulatory requirements, leakage detection, and analytical work performed to understand the causes of high wastage rates (Ref. 12).

Subsequent to significant wastage being discovered on the Davis-Besse RPV head, the industry has performed analysis work to determine how a small leak such as seen at several plants can progress to the significant amounts of wastage discovered at Davis-Besse. This work is referenced in the basis for the MRP Inspection Plan (Ref. 13) and was presented to the NRC (Ref. 14).

The analytical work shows that the corrosion rate is a strong function of the leakage rate. Finite element thermal analyses show that leak rates must reach approximately 0.1 gpm for there to be sufficient cooling of the RPV top head surface to support concentrated liquid boric acid that will produce high corrosion rates. The leak rate is in turn a strong function of the crack length. The effect of crack length above the J-groove weld on crack opening displacement and area has been confirmed by finite element modeling of nozzles including the effects of welding residual stresses and axial cracks. Leak rates have been calculated using crack opening displacements and areas determined by the finite element analyses and leak rate models based on PWSCC cracks in steam generator tubes.

Cracks that just reach the annulus through the base metal or weld metal will result in small leaks such as those that produced small volumes of boric acid deposits on several vessel heads at locations where the CRDM nozzles penetrate the RPV head outside surface. These leaks are typically on the order of 10^{-6} to 10^{-4} gpm. There is no report of any of these leaks resulting in significant corrosion. A leak rate of 10^{-3} gpm will result in a release of about 500 inches cubed (in^3) of boric acid deposits in an 18-month operating cycle which will be detectable by visual inspections.

The time for a crack to grow from a length that will produce a leak rate of 10^{-3} gpm to a leak rate of 0.1 gpm has been determined by deterministic analyses based on the MRP crack growth models to be 1.7 years for plants with 602 degrees Fahrenheit (°F) head temperatures. Probabilistic analyses show that there is less than a 10^{-3} probability that corrosion will proceed to the point that the inside surface cladding of the head would be uncovered over a significant area before the wastage would be detected by supplemental visual inspections as required under the MRP Inspection Plan. During the transition from leak rates of 10^{-3} gpm to 0.1 gpm, loss of material will be by relatively slow processes (Ref. 13).

The ability to detect leakage prior to the risk of structural failure is illustrated by Figure 26 of the Davis-Besse root cause analysis report. There was visual evidence of boric acid deposits on the vessel head for five years prior to the degradation being detected. Guidance provided in the MRP Inspection Plan would not permit these conditions to exist without determining the source of the leak, including NDE if necessary.

Therefore, while the exact timing of the event progression at Davis-Besse cannot be definitively established, the probable durations can be predicted with sufficient certainty to conclude that a visual inspection regimen can ensure continued structural integrity of the RCS pressure boundary.

REFERENCES:

1. TVA letter to NRC dated April 2, 2002, SQN Units 1 and 2 Response to NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002.

2. TVA letter to NRC dated April 2, 2002, WBN Unit 1 Response to NRC Bulletin 2002-01 , "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002.

3. EPRI Letter MRP 2002-086, Transmittal of "PWR Reactor Pressure Vessel (RPV) Upper Head Penetrations Inspection Plan, Revision 1, August 6, 2002," from Leslie Hartz, MRP Senior Representative Committee Chairman, August 15, 2002.

---

4. EPRI Document MRP-75, Technical Report 1007337, "PWR Reactor Pressure Vessel (RPV) Upper Head Penetrations Inspection Plan (MRP-75), Revision 1, September 2002.

5. EPRI Technical Report 1006899, "Visual Examination for Leakage of PWR Reactor Head Penetrations on Top of the RPV Head: Revision 1, March, 2002.

6. Appendix B of EPRI Document MRP-75, Technical Report 1007337, "Probability of Detecting Leaks in RPV Top Head Nozzles," September 2002.

7. EPRI TR-103696, "PWSCC of Alloy 600 Materials in PWR Primary System Penetrations," July 1994.

8. Appendix A of EPRI Document MRP-75, Technical Report 1007337, "Technical Basis for CRDM Top Head Penetration Inspection Plan," September 2002.

9. EPRI Document MRP-55, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material," July 2002.

10. Walton Jensen, NRC, Reactor Systems Branch, Division of Systems Safety and Analysis (DSSA), Sensitivity Study of PWR Reactor Vessel Breaks, memo to Gary Holahan, NRC, DSSA, May 10, 2002.

11. Davis-Besse Nuclear Power Station report CR2002-0891, "Root Cause Analysis Report - Significant Degradation of the Reactor Pressure Vessel Head," April 2002.

12. EPRI Technical Report 1007336, "Proceedings of the EPRI Boric Acid Corrosion Workshop, July 25-26, 2002 (MRP-77)," September 2002.

13. Appendix C of EPRI Document MRP-75, "Supplemental Visual Inspection Intervals to Ensure RPV Closure Head Structural Integrity," August 2002.

14. Glenn White, Chuck Marks and Steve Hunt, Technical Assessment of Davis-Besse Degradation, Presentation to NRC Technical Staff, May 22, 2002.

15. TVA letter to NRC dated June 13, 2002, SQN Unit 2 30-Day Response to NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002.

ENCLOSURE 2

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

THIRTY-DAY RESPONSE TO NRC BULLETIN 2002-02, "REACTOR PRESSURE VESSEL (RPV) HEAD AND VESSEL HEAD PENETRATION (VHP) NOZZLE INSPECTION PROGRAMS"

LIST OF COMMITMENTS

---

1. TVA will revise its program for inspection of the RPV head and vessel head nozzles to implement the Materials Reliability Project (MRP) Inspection Plan. This will include:

   A. Complying with the MRP Inspection Plan requirements by spring of 2003.

   B. Performing and documenting RPV head BMV inspections at TVA in accordance with written procedures and acceptance criteria that comply with the guidance of the MRP Inspection Plan.

   C. Evaluating any boric acid deposit on the vessel head to determine its source in accordance with existing industry guidance, supplemented by the most recent industry experience at the time of the inspection.