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September 11, 2002

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKET NOS. 50-445 AND 50-446
30-DAY RESPONSE TO BULLETIN 2002-02, "REACTOR PRESSURE VESSEL HEAD AND VESSEL HEAD PENETRATION NOZZLE INSPECTION PROGRAMS"

REF: Letter from C. L. Terry to the NRC logged TXX-02067, dated April 2, 2002.

Gentlemen:

TXU Generation Company LP (TXU Energy) understands the subject bulletin addresses a significant issue that requires industry action. TXU Energy will remain actively engaged in resolution of the issue through industry interaction regarding ongoing and future examinations and inspections, participation in the Electric Power Research Institute's Material Reliability Program (MRP), and participation in the development of consensus inspection requirements. In addition, despite unique circumstances at each plant, the six STARS licensees will actively collaborate to share knowledge, equipment, and experience regarding this issue.

TXU Energy completed a bare metal visual inspection for Unit 2 during the spring refueling outage in April of this year and intends to complete the same for Unit 1 during the upcoming fall 2002 outage. These bare metal visual inspections of CPSES Units 1 and 2 meet the basic requirements of both the MRP Inspection Plan and the

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NRC's "Example Supplemental Inspections" for each unit's next two operating cycles.

Consistent with the CPSES culture of conservative decision-making, TXU Energy recognizes the need for comprehensive strategies to resolve this issue. Future inspection plans at CPSES will be developed consistent with industry-developed consensus inspection requirements acceptable to the NRC as referenced within the "Discussion" text of Bulletin 2002-02. In addition, through our participation in the MRP, we will support efforts to identify, develop, and implement improved technologies for both periodic reactor pressure vessel (RPV) head inspection and continuous local leak detection.

The attachment to this letter contains the TXU Energy response to item 1 of the Requested Information in U. S. Nuclear Regulatory Commission (NRC) Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Programs" dated August 9, 2002. TXU Energy previously committed (see referenced letter) to perform a bare metal visual inspection of both CPSES units during their next scheduled refueling outages. The inspection of Unit 2 was completed in April 2002 during 2RFO6. The inspection of Unit 1 is scheduled for October 2002 during 1RFO9.

This communication contains the following new or revised commitments:

Commitment Number	Commitment
27273	Future inspection plans at CPSES will be developed consistent with industry-developed consensus inspection requirements acceptable to the NRC as referenced within the "Discussion" text of Bulletin 2002-02. TXU Energy will provide an update to the NRC regarding those plans no later than August 9, 2006.

If you should have any questions regarding this submittal, please contact Mr. J. D. Seawright at (254) 897-0140.

I state under penalty of perjury that the foregoing is true and correct.

Executed on September 9, 2002.

Sincerely,

TXU Generation Company LP

By: TXU Generation Management Company LLC,
Its General Partner

C. L. Terry
Senior Vice President and Principal Nuclear Officer

By: Roger D. Walker
Roger D. Walker
Regulatory Affairs Manager

JDS/js
Attachment

c - E. W. Merschoff, Region IV
W. D. Johnson, Region IV
D. H. Jaffe, NRR
Resident Inspectors, CPSES

CPSES Response to NRC Bulletin 2002-02

NRC Requested Information:

(1) Within 30 days of the date of this bulletin:

A. PWR addressees who plan to supplement their inspection programs with non-visual NDE methods are requested to provide a summary discussion of the supplemental inspections to be implemented. The summary discussion should include EDY, methods, scope, coverage, frequencies, qualification requirements, and acceptance criteria.

B. PWR addressees who do not plan to supplement their inspection programs 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 the 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 a discussion of your basis for concluding that unacceptable vessel head 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.

CPSES Response:

TXU Energy has evaluated the expected status of Comanche Peak Units 1 & 2 with regard to accrued Effective Full Power Years (EFPY). The corresponding values for Effective Degradation Years (EDY) were then calculated in accordance with MRP-48 (Equation 2.2) (Ref. 13) based on a head temperature at the nominal T_{cold} value of 561 °F. The results are presented in the following table referenced to the next scheduled refueling outage for each unit:

Unit	EDY	As of Next RFO / Date	EDY / EFPY accrual rate
CPSES Unit 1	~2.1	1RFO9 / Oct. 2002	0.195
CPSES Unit 2	~1.8	2RFO7 / Fall 2003	0.195

Our responses to NRC Bulletin 2002-01 (TXX-02067 and TXX-02103) addressed the adequacy of visual inspection for compliance with the design and licensing basis of the CPSES units. Those responses are still applicable. Additional technical justification for the adequacy of the inspections is provided in this response to Bulletin 2002-02.

TXU Energy previously committed in TXX-02067 dated April 2, 2002 to perform a bare metal visual inspection of both CPSES units during their next scheduled refueling outages. The inspection of Unit 2 was completed in April 2002 during 2RFO6 as reported in TXX-02103, dated June 3, 2002. The inspection of Unit 1 is scheduled for October 2002 during 1RFO9.

The MRP Inspection Plan for reactor pressure vessel heads has been developed, reviewed, and approved by the PWR utilities (Refs. 1 and 2). It presents a technically credible inspection regimen that assures to a high degree of certainty that RPV head penetration leaks will be detected at an early stage long before wastage or circumferential cracking can challenge the structural integrity of the RCS pressure boundary. Furthermore, implementation of the MRP Inspection Plan will assure continued compliance with the existing Regulatory Requirements cited by the NRC within Bulletin 2002-02 pending implementation of a long-term inspection plan (CPSES commitment #27273).

Therefore, TXU Energy will implement the requirements of the MRP Inspection Plan (Ref. 2) as they apply to the conduct of the next planned Bare Metal Visual (BMV) inspection of Unit 1 in October 2002. The MRP Inspection Plan encompasses the inspection commitments made in our responses to Bulletin 2001-01 and Bulletin 2002-01, but contains more comprehensive and rigorous guidance regarding the overall conduct of the visual inspection and the necessary response to observed conditions. However, the inspection performed in April of this year on CPSES Unit 2 has been reviewed against and fully complied with these requirements. TXU Energy will remain actively engaged in industry efforts to implement technically credible inspection requirements within the ASME B&PV Code as discussed in Bulletin 2002-02. Future inspections in either unit will be scheduled based on CPSES and industry-wide inspection results and the developing consensus requirements for a long-term reactor vessel head inspection plan.

TXU Energy provides the following additional information as justification for our current continued reliance on visual examinations as the primary method to detect degradation in the RPV head. Included in these responses are discussions of the reliability and effectiveness of visual examinations as they relate to the six concerns cited in Bulletin 2002-02 and the basis for concluding that unacceptable wastage will not occur between inspections.

NRC Concern 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 examination 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.

EPRI MRP has published detailed guidance for performing visual examinations of RPV heads (Refs. 2 and 3). TXU personnel have actively participated in both the development of this guidance and the utility workshop conducted recently to discuss this guidance and lessons learned from recent field experience (including Davis-Besse). RPV head bare metal visual inspections at CPSES (beginning with the Unit 2 April 2002 inspection) have been and will continue to be performed and documented in accordance with written procedures and acceptance criteria that comply with the guidance of the MRP Inspection Plan and incorporate industry lessons learned. Evaluations and corrective actions are rigorous and thoroughly documented in accordance with applicable site administrative controls.

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) penetration 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. Industry experience, both in the United States and Europe, has shown that through-wall axial cracks will 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 all roll expanded but still developed leaks during operation (Ref. 4). Plant specific RPV 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. 4)

The probability of detecting small CRDM penetration leaks solely by visual inspections is high. "Visual inspections of the reactor coolant system pressure boundary have been proven to be an effective method for identifying leakage from 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. 5). To date, all leaking CRDM nozzles have first been discovered by visual methods with subsequent confirmation by non-visual NDE examinations except for the three nozzles at Davis-Besse. However, in these three instances, 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 4).

Finally, as described under Concern 3 below, detailed probabilistic fracture mechanics (PFM) analyses have been performed under the direction of the MRP to demonstrate the effectiveness of visual inspections in protecting the CRDM nozzles against failure due to circumferential cracking. (Ref. 6). 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% probability that leakage will be 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% probability of detecting the leak. Even with these conservative assumptions relative to probability of detection, 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. Bounding analyses for plants with very low accumulated EDY, such as the CPSES units, demonstrate that the probability of nozzle ejection remains more than an order of magnitude below the NRC Regulatory Guide 1.174 guidance (discussed under Concern 3 below) for probability of nozzle ejection, with no inspection whatsoever. Inspection of these plants in accordance with the MRP Inspection Plan (e.g., Bare Metal Visual once per 10 EFPY) will reduce the probability of nozzle ejection even further.

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 from CRDM nozzles can be detected visually and it has been shown that timely detection by visual examination will ensure the structural integrity of the RPV head penetrations with respect to circumferential cracking. However, TXU Energy will monitor inspection experience through continued participation in industry activities to ensure that this conclusion remains valid.

NRC Concern 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 will leak the same as cracks in the penetration base metal. Therefore, weld cracks pose a similar risk as cracks in the base material and subsequent leakage is 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 (Ref. 2) have been conservatively established based on the risk informed analyses considering leakage due to both weld metal and base metal cracking.

NRC Concern 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: Probabilistic fracture mechanics (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. 6). 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° 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. 7). The parameters used in the PFM model were benchmarked against the most severe cracking found to date in the industry (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 effective full power years (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 Response for Concern 1) 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. 8). The consequences of such an event are similar to that of a small-break LOCA, 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 generically 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} 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 that defines an acceptable change in core damage frequency (1×10^{-6} per plant year) for changes in plant design parameters, technical specifications, etc.

NRC Concern 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 ANL/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 revisited this issue subsequent to the Davis-Besse incident (Ref. 7). When revisited, the relevant arguments remain valid for leak rates that are less than 1 liter/h or 0.004 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 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 chemistry 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 two (2) applied to the crack growth rate (CGR) conservatively covers possible acceleration of PWSCC, even up to a high-temperature pH of approximately nine (9).

For larger leakage rates, which could lead to local cooling of the head, concentration of boric acid, and development of a sizeable 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. 7), which includes a factor of two (2) applied to the CGR to cover residual uncertainty in the composition of the annulus environment, remains valid.

NRC Concern 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 RPV 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, each inspection at Comanche Peak will be conducted with a questioning attitude and in accordance with site-specific procedures. Any boric acid deposit on the vessel head will be evaluated to determine its source, and removed as necessary in accordance with the industry guidance contained within the MRP Inspection Plan. These requirements will be incorporated into the applicable site-specific procedures. Implementation of these requirements will preclude the cited condition of a through-wall crack remaining undetected for years.

As reported in our partial response to Bulletin 2002-01 (TXX-02103) following the recent Unit 2 reactor vessel head inspection, no degradation of the head was observed and no evidence of reactor coolant system pressure boundary leakage during power operation was found. Furthermore, no limitations were encountered that prevented access or inhibited effective inspection of either the general head surface or the annulus at the base of each penetration tube. The condition of Unit 1 will be similarly ascertained during the upcoming refueling outage in October 2002 and the results will be reported per Bulletins 2001-01, 2002-01, and 2002-02.

NRC Concern 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. 9) 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. 9).

Industry guidance has been provided to utilities (Ref. 3) for vessel top head visual inspections to ensure that conditions approaching that which existed at Davis-Besse will not occur. In addition, 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. 10).

Subsequent to significant wastage being discovered on the Davis-Besse RPV head, the industry has performed analytical work to determine how a small leak, such as those seen at several plants, can progress to the significant amounts of wastage discovered at Davis-Besse. This work is referenced within the basis for the MRP Inspection Plan (Ref. 11) and was previously presented to the NRC (Ref. 12).

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 the release of about 500 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 estimated by deterministic analyses based on the MRP crack growth models to be 1.7 years for plants with 602°F head temperatures. Probabilistic analyses show that there is less than a 1×10^{-3} probability that corrosion in such a plant 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. Analyses have further shown that for plants with low temperature RPV heads, such as the CPSES units, the probability of a leak developing and growing to the extent that significant wastage could occur is also very small. The MRP Inspection Plan for low susceptibility plants (Supplemental Visual every other refueling outage) maintains the probability of wastage that would violate ASME B&PV Code, Section III primary stress limits in the head at less than 1 x 10-4. During the transition from leak rates of 10^{-3} gpm to 0.1 gpm, loss of material will be by relatively slow processes (Ref 11).

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 nondestructive examinations 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. 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.
2. EPRI Document MRP-75, Technical Report 1007337, "PWR Reactor Pressure Vessel (RPV) Upper Head Penetrations Inspection Plan (MRP-75), Revision 1", September 2002
3. EPRI Technical Report 1006899, "Visual Examination for Leakage of PWR Reactor Head Penetrations on Top of the RPV Head: Revision 1", March 2002
4. Appendix B of EPRI Document MRP-75, Technical Report 1007337, "Probability of Detecting Leaks in RPV Top Head Nozzles," September 2002
5. EPRI TR-103696, "PWSCC of Alloy 600 Materials in PWR Primary System Penetrations", July 1994.
6. Appendix A of EPRI Document MRP-75, Technical Report 1007337, "Technical Basis for CRDM Top Head Penetration Inspection Plan," September 2002.
7. EPRI Document MRP-55, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material," July 2002.
8. 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.
9. Davis-Besse Nuclear Power Station Report CR2002-0891, "Root Cause Analysis Report – Significant Degradation of the Reactor Pressure Vessel Head," April 2002.
10. EPRI Technical Report 1007336, "Proceedings of the EPRI Boric Acid Corrosion Workshop, July 25-26, 2002 (MRP-77)", September 2002.
11. Appendix C of EPRI Document MRP-75, Technical Report 1007337, "Supplemental Visual Inspection Intervals to Ensure RPV Closure Head Structural Integrity," September 2002.
12. Glenn White, Chuck Marks and Steve Hunt, Technical Assessment of Davis-Besse Degradation, Presentation to NRC Technical Staff, May 22, 2002.
13. EPRI Document MRP-48, "PWR Materials Reliability Program Response to NRC Bulletin 2001-01", August 2001