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A Progress Energy Company

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United States Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23

SUPPLEMENTAL INFORMATION REGARDING
NRC BULLETIN 2001-01, "CIRCUMFERENTIAL CRACKING OF
REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES"

Ladies and Gentlemen:

On August 3, 2001, the Nuclear Regulatory Commission (NRC) issued NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," requesting information related to the structural integrity of the reactor vessel head penetration (VHP) nozzles, including the extent of VHP nozzle leakage and cracking found to date, the inspections and repairs undertaken to satisfy applicable regulatory requirements, and the basis for concluding that planned future inspections will ensure compliance with applicable regulatory requirements.

By letter dated September 4, 2001, H. B. Robinson Steam Electric Plant (HBRSEP), Unit No. 2, provided the information requested by NRC Bulletin 2001-01 under oath and affirmation in accordance with 10 CFR 50.54(f).

During conference calls on September 27 and 28, 2001, the NRC staff identified the need for clarifications regarding the original HBRSEP, Unit No. 2, response to NRC Bulletin 2001-01. The requested information is provided within Attachments II and III to this letter. Additionally, an evaluation of the potential for detecting leakage for the HBRSEP, Unit No. 2, RPV head is provided as an enclosure to this letter. The information provided within this enclosure has been designated as Westinghouse Proprietary Class 2. In accordance with 10 CFR 2.790, HBRSEP, Unit No. 2, requests that the information contained within this enclosure be exempt from public disclosure. A non-proprietary version of this report is being generated and will be provided to the NRC by October 31, 2001.

Robinson Nuclear Plant
3581 West Entrance Road
Hartsville, SC 29550

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As discussed within the original HBRSEP, Unit No. 2, submittal dated September 4, 2001, thorough visual examinations of the entire reactor vessel head were performed during Refueling Outage (RO) - 20 in April 2001. Examinations were performed by Quality Control (QC) personnel and were conducted as VT-2 visual examinations with the RPV head insulation removed and prior to cleaning or decontamination activities in the areas examined. The examinations confirmed that no evidence of VHP nozzle leakage or reactor coolant system pressure boundary leakage existed.

The HBRSEP, Unit No. 2, examinations performed during RO-20 are considered to be qualified visual examinations, as discussed within NRC Bulletin 2001-01, with the exception of plant-specific demonstrations or analyses regarding the ability to detect through-wall cracking by evidence of leakage to the RPV head. The VT-2 visual examinations performed during RO-20 were not compromised by the presence of RPV head insulation and were effective in distinguishing sources of boric acid deposition. A detailed finite element analysis of the HBRSEP, Unit No. 2, CRDM nozzles and the penetrations in the RPV head metal is presently being performed. The results of this analysis are expected to be available for NRC review by October 31, 2001. This analysis is expected to complete the requisite documentation that the examinations performed during RO-20 were in fact qualified visual examinations.

As requested by Item No. 3 of NRC Bulletin 2001-01, the HBRSEP, Unit No. 2, submittal dated September 4, 2001, provided plans for future inspections (type and scope, qualification requirements, and acceptance criteria) and the basis for concluding that these future plans will continue to meet regulatory requirements. Inspections performed to-date, when combined with the planned additional analyses and inspections, provide the basis for concluding that HBRSEP, Unit No. 2, can continue to operate in a safe manner consistent with the licensing basis. The supplemental information provided by this letter does not alter or affect the conclusion that HBRSEP, Unit No. 2, remains in compliance with applicable Code of Federal Regulations and Technical Specifications requirements.

If you have any questions regarding this matter, please contact Mr. H. K. Chernoff.

Sincerely,

B. L. Fletcher III
Manager - Regulatory Affairs

CTB/ctb

Attachments:

I. Affidavit
II. Supplemental Information Regarding NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles"
III. Detailed Chronology Of Reactor Pressure Vessel Head Examinations Performed During Refueling Outage 20

Enclosure:

Evaluation of the Potential for Detectable Leakage in H. B. Robinson Reactor Vessel Head

c: Mr. B. S. Mallett, NRC, Region II
Mr. R. Subbaratnam, NRC, NRR
NRC Resident Inspectors

AFFIDAVIT

State of South Carolina
County of Darlington

J. W. Moyer, having been first duly sworn, did depose and say that the information contained in letter RNP-RA/01-0153 is true and correct to the best of his information, knowledge, and belief; and the sources of this information are officers, employees, contractors, and agents of Carolina Power and Light Company.

J Moyer

Sworn to and subscribed before me

this 2nd day of October, 2001

Notary Public for South Carolina

My commission expires: 9/13/2009

H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2

SUPPLEMENTAL INFORMATION REGARDING
NRC BULLETIN 2001-01, "CIRCUMFERENTIAL CRACKING
OF REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES"

1. Additional information has been requested by the NRC staff regarding the sequence and scope of visual examinations performed during Refueling Outage 20 (RO-20) and the extent to which these examinations constitute a "qualified visual examination" in accordance with NRC Bulletin 2001-01.

Response

Examinations performed during RO-20 for the purpose of identifying VHP nozzle leakage were performed by Quality Control (QC) personnel and were conducted as VT-2 visual examinations on April 14, 2001 and April 19, 2001. A detailed chronology of these examinations is provided within Attachment III to this letter. These VT-2 visual examinations were performed with RPV head insulation removed and prior to cleaning or decontamination activities in the areas examined. These examinations were effective in distinguishing sources of boric acid deposition and confirmed that no evidence of VHP nozzle leakage or reactor coolant system pressure boundary leakage existed. Attachment III, Figure 1, depicts the total area of these examinations. Control rod drive mechanism (CRDM) locations are represented in this figure by their alphanumeric designator.

The HBRSEP, Unit No. 2, examinations performed during RO-20 are considered to be qualified visual examinations, as discussed within NRC Bulletin 2001-01, with the exception of plant-specific demonstrations or analyses regarding the ability to detect through-wall cracking by evidence of leakage to the RPV head. The VT-2 visual examinations performed during RO-20 were not compromised by the presence of RPV head insulation and were effective in distinguishing sources of boric acid deposition. A detailed finite element analysis of the HBRSEP, Unit No. 2, CRDM nozzles and the penetrations in the RPV head metal is being performed. The results of this analysis are expected to be available for NRC review by October 31, 2001. This analysis is expected to complete the requisite documentation that the examinations performed during RO-20 were in fact qualified visual examinations.

2. Additional information has been requested by the NRC staff regarding the HBRSEP, Unit No. 2, VHP nozzle interference fit.

Response

In the HBRSEP, Unit No. 2, submittal dated September 4, 2001, the Design Nozzle Interference Fit was identified as 0.0 to 0.003 inches.

The "PWR Materials Reliability Program Response to NRC Bulletin 2001-01 (MRP-48)" was issued in August 2001. The report summary notes that the CRDM nozzle leaks discovered in late 2000 and early 2001 were identified by visual inspection of reactor vessel heads. The visual inspections detected boric acid crystal deposits that came from the annular space between the CRDM nozzles and the penetrations in the reactor vessel head metal. This location is characterized by the shrink fit of the nozzles into the vessel head during fabrication. This results in a tight fit between the nozzle and head penetration and would tend to retard leakage along the outside of the nozzle tube. Nevertheless, leakage was readily detected by visual means.

As an initial step to determine the efficacy of visual detection of potential leaks on the HBRSEP, Unit No. 2, RPV head, an evaluation was performed by Westinghouse, which is provided as an enclosure to this letter. This Westinghouse evaluation considered the likelihood of detecting a leak from a through-wall crack in the CRDM nozzle or the nozzle attachment weld by visual means. The Westinghouse evaluation was based on a simplified analysis of the behavior of the nozzles (as a thick-walled cylinder) and the vessel head (as a perforated thin-walled sphere) under the effects of increased temperature and pressure. The evaluation demonstrated that the interference fit between the CRDM nozzle and the vessel head tends to relax as the reactor coolant system is taken from cold shutdown conditions to normal operating temperature and pressure. It was concluded that interference fits initially below a certain dimension would exhibit either no interference or a gap when raised to normal temperature and pressure conditions. For these penetrations, it is reasonable to assume that leakage onto the vessel head would occur and would be detected by visual inspection.

The Westinghouse evaluation was based on a range of possible interference fits. Since only design data is available for HBRSEP, Unit No. 2, "as measured" dimensions for the penetration were compared to the nominal nozzle diameter from three plants manufactured by Combustion Engineering, the HBRSEP, Unit No. 2, vessel manufacturer, during the time frame when the HBRSEP, Unit No. 2, RPV head was fabricated. In addition, "as measured" data for both nozzles and penetrations from two additional Westinghouse plants were obtained and incorporated into the evaluation. The data provide a reasonable picture of the typical distribution of interference fit dimensions for CRDM penetrations in plants fabricated to Westinghouse specifications.

The penetration at the center of the head was modeled to provide radial symmetry; and, it was noted that the locations closer to the edge of the vessel head would be more inclined to form leakage gaps. This results from the non-symmetrical expansion of the vessel penetrations (ovalization) as pressure and temperature increase. Forty-four of the 69 CRDM penetrations in the HBRSEP, Unit No. 2, RPV head are located in the outer two rows of penetrations. Owing to their location, these would be expected to exhibit a greater tendency to expand in a non-symmetrical way and thus more likely to form leakage gaps.

The Westinghouse evaluation provides the probability that a visual inspection would identify leakage from a central CRDM nozzle location. This represents the most limiting configuration. As described above, other nozzle locations (i.e., locations other than the center) would be expected to have a higher likelihood of forming leakage gaps. As a result, the fraction of penetrations that would exhibit visible leakage is expected to be much higher than the 50% to 56% predicted by the Westinghouse evaluation for the central location. For details of the evaluation, refer to the enclosed report, "Evaluation of the Potential for Detectable Leakage in H B Robinson Reactor Vessel Head."

A detailed finite element analysis of the HBRSEP, Unit No. 2, CRDM nozzles and penetrations in the RPV head metal is being performed, the results of which are expected to be available for NRC review by October 31, 2001.

DETAILED CHRONOLOGY OF REACTOR PRESSURE VESSEL HEAD EXAMINATIONS PERFORMED DURING REFUELING OUTAGE 20

April 10, 2001

During Refueling Outage 20 (RO-20) activities to detension the reactor pressure vessel (RPV) head studs, evidence of primary system leakage was identified on the surface of the reactor vessel head, including the reactor vessel head insulation and control rod drive mechanism (CRDM) housings.

April 14, 2001

Quality Control (QC) inspectors performed an "as-found" VT-2 visual examination of the reactor vessel head with the insulation in place. The purpose of this VT-2 visual examination was to investigate the evidence of primary system leakage, i.e., boric acid deposition, which had been identified on April 10, 2001. The boric acid deposition was primarily located in the vicinity of CRDM locations B10, C9, D8, and D10, with the spray pattern indicating that the majority was centered around location B10 (Figure 2). The source of the leakage was identified as the canopy seal weld at CRDM location B10, which did not constitute reactor coolant system pressure boundary leakage. During this VT-2 visual examination, lower canopy seal welds at each CRDM location were examined using direct visual examination for accessible surfaces and a magnifying mirror for surfaces that were not directly accessible.

April 15, 2001

The RPV head lower shroud was partially removed and metallic thermal insulation was removed from areas exposed to boric acid. This included an area approximately two feet wide by seven feet long. As shown on Figure 3, this included CRDM locations D8, B8, C9, D10, E11, F12, G13, H14, B10, C11, D12, E13, and F14. Subsequently, a VT-2 visual examination was completed by QC personnel to map the boric acid deposition on the RPV head. Specific orientation, related to the type of boric acid deposition associated with vessel head penetration (VHP) nozzle leakage identified at Oconee Nuclear Station Unit 3 (ONS3), was given to these personnel prior to the examination. The observed boric acid deposition on the RPV was recorded and attributed to leakage flowing onto the RPV head from the CRDM location B10 canopy seal weld above. No deposition or evidence of leakage was identified that could be attributed to leakage or degradation of the VHP nozzle welds or Alloy 600 material. Following completion of this examination, actions were initiated to clean the affected area (Figure 3) in preparation for base metal examinations to determine whether the boric acid deposition had resulted in corrosion or wastage.

April 16, 2001 — Cleaning of the affected RPV head areas (Figure 3) was completed without removal of additional insulation. Additionally, a VT-2 visual examination was completed by QC personnel to examine the affected area. This examination was focused on determining if corrosion damage was present on the RPV head or other components that may have been subjected to boric acid deposition. Scattered areas of light to medium rust were noted, with no evidence of metal loss or pitting detected. The area of interface between the reactor vessel head and CRDM nozzles was inspected with no distorted metal or discoloration noted.

April 18, 2001 — Based on information received from NRC and the Nuclear Energy Institute (NEI) regarding VHP nozzle cracking, the decision was made to remove the remaining RPV head insulation (Figure 4) and perform a VT-2 visual examination of the entire RPV head. This examination was focused on identifying evidence of leakage or degradation of the VHP nozzles or Alloy 600 material.

April 19, 2001 — The remaining RPV head insulation was removed. Subsequently, QC personnel completed a VT-2 visual examination of the CRDMs and RPV head. Specific orientation, related to the type of boric acid deposition associated with VHP nozzle leakage identified at ONS3, was given to these personnel prior to the examination. This examination was performed prior to cleaning or decontamination activities for the area depicted in Figure 4. No evidence of VHP nozzle leakage or reactor coolant system pressure boundary leakage was identified.

The area depicted in Figure 3, which was inspected on April 15, 2001, prior to cleaning or decontamination activities, was again examined. Each VHP nozzle was inspected to the extent necessary to ascertain that no upward boron leakage pattern existed as seen within the ONS3 videotape. No metal discoloration or new boron deposition was identified.

Figure 1

The total area of the RPV head that was subjected to VT-2 visual examination during RO-20 is designated by the shaded locations. These examinations were performed with RPV head insulation removed and prior to cleaning or decontamination activities.

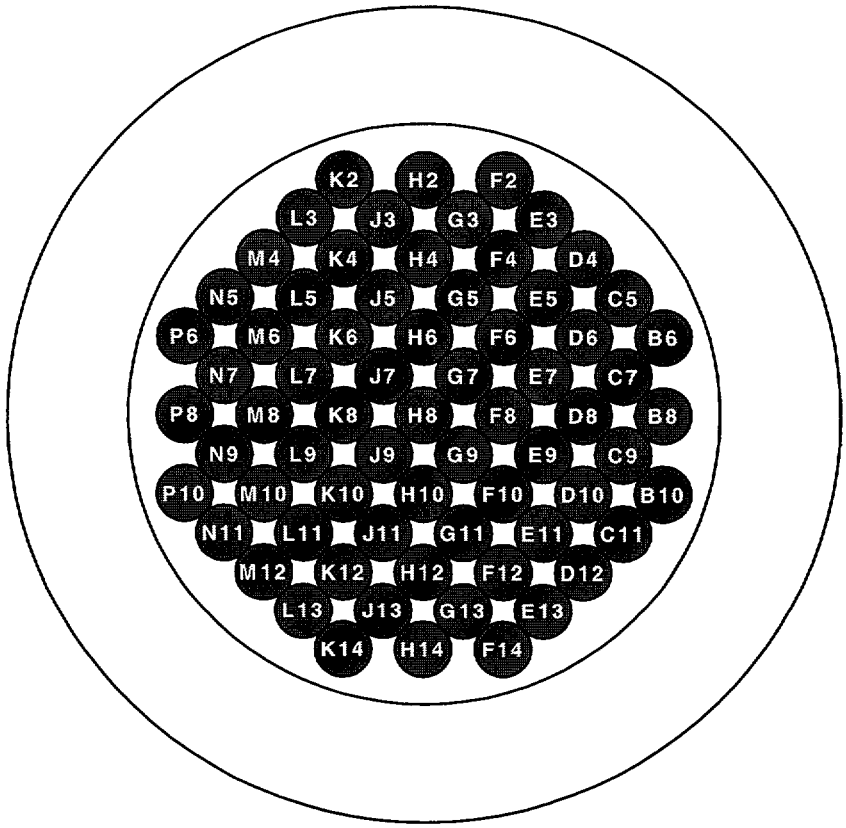

Figure 2

The shaded locations designate the area of VT-2 visual examination on April 14, 2001. This examination was performed to investigate evidence of primary system leakage associated with the canopy seal weld at CRDM location B10. This inspection was performed with RPV head insulation in place and prior to cleaning or decontamination activities.

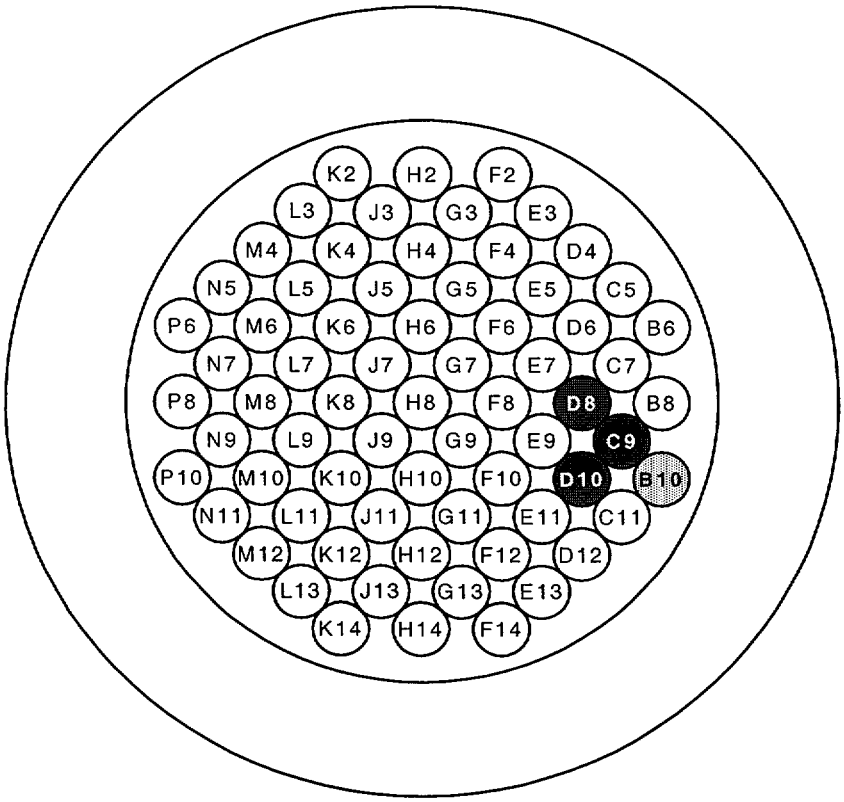

Figure 3

The shaded locations designate the area of VT-2 visual examination on April 15, 2001, where mapping of boric acid deposition was performed. This mapping included examination for evidence of leakage attributable to VHP nozzles. Examination activities were performed with RPV insulation removed from the affected area and were performed prior to cleaning or decontamination activities.

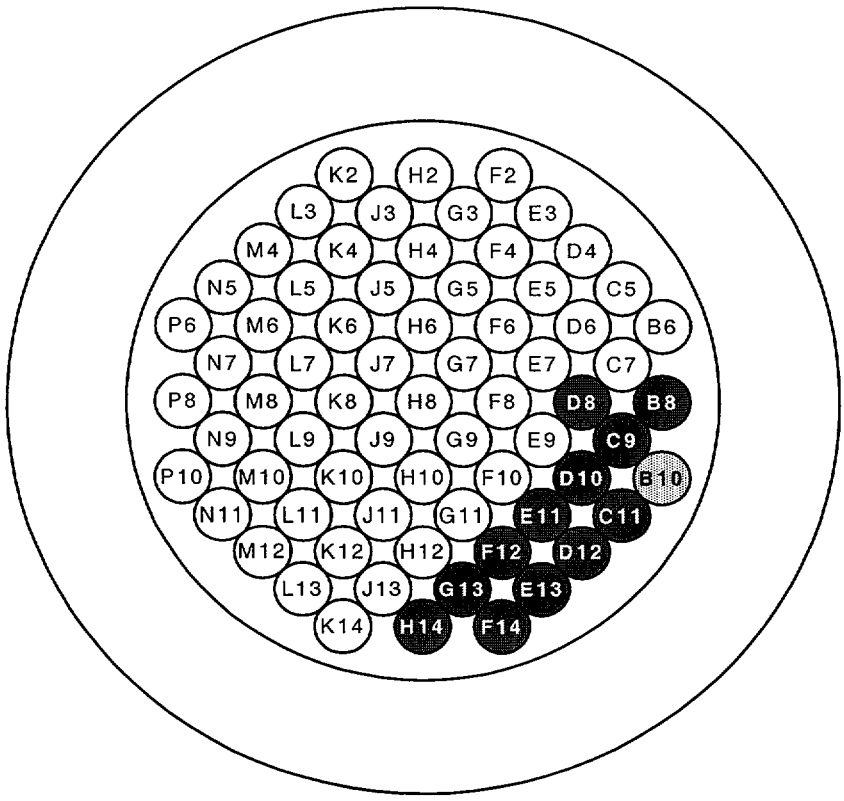

Figure 4

The shaded locations designate the area of VT-2 visual examination performed on April 19, 2001, to address concerns regarding VHP nozzle cracking. Examinations were performed with RPV head insulation removed and prior to cleaning or decontamination activities. These examinations were effective in distinguishing sources of boric acid deposition and confirmed that no evidence of VHP nozzle leakage or reactor coolant system pressure boundary leakage existed.