VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 11, 2002

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No. 01-490E
NL&OS/ETS R0
Docket No. 50-339
License No. NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 2
SUPPLEMENTAL RESPONSE TO NRC BULLETIN 2001-01 CIRCUMFERENTIAL CRACKING OF REACTOR VESSEL HEAD PENETRATION NOZZLES
RESULTS OF REACTOR VESSEL HEAD PENETRATION INSPECTIONS

In a letter dated August 31, 2001 (Serial No. 01-490), Virginia Electric and Power Company (Dominion) responded to NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head (RVHP) Penetration Nozzles." Item 5 of the Requested Information section of the Bulletin requested licensees to provide the following information within 30 days after plant restart following the next refueling outage:

"a. a description of the extent of VHP nozzle leakage and cracking detected at your plant, including the number, location, size, and nature of each crack detected;

b. if cracking is identified, a description of the inspections (type, scope, qualification requirements, and acceptance criteria), repairs, and other corrective actions you have taken to satisfy applicable regulatory requirements. This information is requested only if there are any changes from prior information submitted in accordance with this bulletin."

The requested reactor vessel head penetration (RVHP) nozzle inspections for North Anna Unit 2 were performed during a recent maintenance outage in November 2001. Cracking was identified in the area of the welds for three of the RVHP nozzles. Also, indications on the inner diameter (ID) of the penetration tubes were identified on the same three penetrations. The ID indications associated with the three penetrations (i.e., Penetration Nos. 51, 62 and 63) were evaluated by fracture mechanics, and it was determined that these indications would not compromise structural integrity. The cracking associated with the welds was repaired. Periodic inspection of the indications on the ID of the penetration tubes associated with these three penetrations will be

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performed during subsequent refueling outages, as required by ASME Section XI, to monitor potential growth of the indication and prevent compromising the structural integrity of the pressure boundary. Specific inspection information and the disposition of the indications associated with these three penetrations are provided in the attachment.

If you have any questions or require additional information, please contact us.

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering

Attachment

Commitments made in this letter:

1. A copy of the final metallurgical analysis report, when received from Westinghouse, will be forwarded to the NRC.

cc: U.S. Nuclear Regulatory Commission
Region II
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SN: 01-490E
Docket No.: 50-339
Subject: NRC Bulletin 2001-01 – Results of RVH Penet. Inspections

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President - Nuclear Engineering, of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 11th day of January, 2002.

My Commission Expires: March 31, 2004.

Maggie McClure
Notary Public

(SEAL)

Attachment

NRC Bulletin 2001-01, Circumferential Cracking of Reactor Pressure Vessel Head (RVHP) Penetration Nozzles

Reactor Vessel Head Penetration Nozzles Inspection Results for North Anna Unit 2

Virginia Electric and Power Company
(Dominion)

NRC BULLETIN 2001-01
REACTOR VESSELHEAD PENETRATION NOZZLES INSPECTION RESULTS
NORTH ANNA POWER STATION UNIT 2

QUALIFIED INSPECTION RESULTS

Using a combination of robotic inspection cameras and a boroscope, a visual inspection of the Unit 2 vessel head penetrations was performed. Of the 65 penetrations inspected, seven were initially reported with relevant indications. Penetrations N2-31, 39, 46, and 49 appeared to have loose boric acid debris accumulation at the top portion of the interface. The robotic camera was positioned to observe the uphill side of the penetrations while the subject area was interrogated with 40-psig air applied through a ¼" tube. The debris/boric acid mix on the uphill side was easily dispersed. Industry experience has shown that boric acid residue from leaking penetrations has a tight adherence to the annulus region and is not easily removed. After applying this process, Penetrations 31, 39, 46, and 49 were determined to be acceptable. However, Penetrations 51, 62 and 63 still had rejectable indications, and further NDE inspection was performed.

NDE INSPECTION RESULTS

A summary of the reactor vessel head inspections for each penetration with confirmed axial indications and their disposition is provided below. No circumferential cracking was identified during the course of the inspections.

Key to Acronyms:

E/C OD	Eddy Current Outer Diameter
E/C ID	Eddy Current Inner Diameter
UT ID	Ultrasonic Testing Inner Diameter
LP OD	Liquid Penetrant Outer Diameter

Penetration 51:

LP: Liquid Penetrant (LP) examination of the entire weld surface revealed twelve indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Five of the indications were parallel to the weld, and seven were transverse.

E/C ID: Eddy Current (E/C) inspection on the inside diameter of the penetration in the area of the attachment weld under the vessel head was performed, and six axial indications were reported:

UT ID: This thermocouple penetration does not have a thermal sleeve. An Ultrasonic Test (UT) examination of the ID of the tube was performed to confirm and determine the depth of the indications found using E/C. All indications were <1 mm deep with the exception of number 3, which had a depth of <2 mm. The following lengths were determined using UT:
Indications #1 and #2, 24-mm long cluster (craze cracking)
Indication #3, 10 mm long
Indication #4, 6 mm long
Indication #5, 12 mm long
Indication #6, 6 mm long

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the OD of the tube. There were no reportable indications using this method.

Evaluation: Eddy current and ultrasonic inspection results for this vessel head penetration demonstrate that there is no evidence of a flaw propagating from the OD of the penetration or the penetration to weld fusion zone toward the ID and around the penetration circumferentially. Using methodology obtained from WCAP-14552, the shallow indications detected at the ID of the penetration tube have been evaluated to determine the additional service life allowable before repair. This approach began with detailed stress analyses of the vessel head penetrations. The results of the stress analysis provided input that was applied directly to crack growth analyses. This evaluation determined an allowed operating time of 5.6 years with indications at the ID of this penetration. Periodic inspection of the indication during refueling outages will monitor potential growth of the indication and prevent compromising the structural integrity of the pressure boundary.

Repairs: The guide funnel on this thermocouple penetration was removed to allow welding equipment access to the area of the LP indications at the toe of the attachment weld. A weld overlay was then applied to embed these indications and prevent growth and a new guide funnel was attached. During a phone call with the NRC on November 16, 2001, North Anna was given verbal approval to use this embedded flaw repair technique based on an assessment of the affect of the flaws on the structural integrity as derived from WCAP-14552.

Penetration 62:

LP: LP examination of the entire weld surface revealed eight indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Two of the recorded indications were parallel to the weld, and six were transverse.

E/C ID: E/C inspection on the inside diameter of the penetration in the area of the attachment weld under the vessel head was performed, and two axial cluster indications (craze cracking) were reported:

UT ID: The thermal sleeve was removed to facilitate inspection of the tube. A UT examination of the ID was performed to confirm and determine the depth of the indications found using E/C. Indication number 1 was <2 mm deep. Indication number 2 was <1 mm deep. The following lengths were determined using UT:
Indication #1, 74 mm long
Indication #2, 42 mm long

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the OD of the tube. There were no reportable indications using this method

Evaluation: Eddy current and ultrasonic inspection results for this vessel head penetration demonstrate that there is no evidence of a flaw propagating from the OD of the penetration or the penetration to weld fusion zone toward the ID and around the penetration circumferentially. Using methodology obtained from WCAP-14552, the shallow indications detected at the ID of the penetration tube have been evaluated to determine the additional service life allowable before repair. This approach began with detailed stress analyses of the vessel head penetrations. The results of the stress analysis provided input that was applied directly to crack growth analyses. This evaluation determined an allowed operating time of 5.6 years with indications at the ID of this penetration. Periodic inspection of the indication during refueling outages will monitor potential growth of the indication and prevent compromising the structural integrity of the pressure boundary.

Additional Interrogation of N2-62 LP Indications:

Each J-groove weld has a butter layer between the attachment weld and the vessel cladding. To clarify which material contains the indications at the toe of the welds, acid etching of the suspect area was performed on Penetration N2-62. This inspection revealed an area of smooth surface Inconel ®, 10-15 mm wide from the toe of the weld buildup to the stainless steel cladding. Per drawings, the butter layer in the J-groove weld is 6 mm thick, so it appears that the butter extends an additional 4 to 9 mm onto the vessel surface. This confirmed that the indications were contained in the butter layer-weld surface interface.

A boat sample of the weld material at a location where indications were identified by the LP exam was removed and sent to Westinghouse for laboratory analysis. This N2-62 sample is representative of the

indications found in the welds for Penetrations N2-51 and 63. Preliminary analysis of the sample confirmed that the indications found using LP were most likely associated with original fabrication and not Primary Water Stress Corrosion Cracking (PWSCC). A copy of the final metallurgical analysis report, when received from Westinghouse, will be forwarded to the NRC.

Repairs: The area excavated for the boat sample was repaired using the ambient temperature temperbead repair technique. A weld overlay was then applied to embed the other LP indications and prevent growth and a new thermal sleeve was installed. During a phone call with the NRC on November 16, 2001, North Anna was given verbal approval to use these repair techniques based on an assessment of the affect of the flaws on the structural integrity as derived from WCAP-14552.

Penetration 63:

LP: LP examination of the entire weld surface revealed twelve indications at the toe of the weld, which appeared to be contained in the cladding material. No indications were noted on the weld surface. Six of the recorded indications were parallel to the weld, and six were transverse.

E/C ID: E/C inspection on the inside diameter of the penetration in the area of the attachment weld under the vessel head was performed, and one axial indication was reported.

UT ID: The thermal sleeve was removed to facilitate inspection of the tube. A UT examination of the ID was performed to confirm and determine the depth of the indication found using E/C. The depth of the indication was <1 mm, and the length was 14 mm.

UT OD: A UT examination using pulse echo probes inside the tube (45° forward/up and 45° backward/down) was performed focusing on the OD of the tube. There were no reportable indications using this method.

Evaluation: Eddy current and ultrasonic inspection results for this vessel head penetration demonstrate that there is no evidence of a flaw propagating from the OD of the penetration or the penetration to weld fusion zone toward the ID and around the penetration circumferentially. Using methodology obtained from WCAP-14552, the shallow indications detected at the ID of the penetration tube have been evaluated to determine the additional service life allowable before repair. This approach began with detailed stress analyses of the vessel head penetrations. The results of the stress analysis provided input that was applied directly to crack growth analyses. This evaluation determined an

allowed operating time of 8.1 years with the indication at the ID of this penetration. Periodic inspection of the indication during refueling outages will monitor potential growth of the indication and prevent compromising the structural integrity of the pressure boundary.

Additional Interrogation of N2-63 LP Indications:

To further characterize the indications found during LP testing, a portion of the weld around Penetration N2-63 (approximately 2-3/4" long) was excavated to a depth of approximately 1-inch. LP examination of this excavation shows that there is an indication located in the outside edge of the weld the full length of the excavation, which turns into the weld at the uphill and downhill ends of the excavation. Additional indications found during LP testing were partially excavated using manual grinding, and the indications were not completely removed.

Repairs: The excavated areas were repaired using the ambient temperature temperbead repair technique. A weld overlay was then applied to embed the other LP indications and prevent growth and a new thermal sleeve was installed. During a phone call with the NRC on November 16, 2001, North Anna was given verbal approval to use these repair techniques based on an assessment of the affect of the flaws on the structural integrity as derived from WCAP-14552.

CONCLUSION

Following repairs and after a thorough review of the visual inspection and NDE inspection of the North Anna Unit 2 reactor vessel head penetrations, it is concluded that the use of the repair process discussed above did not result in any change to system capacity rating, system output, component operating requirements, component operating characteristics, or intended design function.

The limiting factor in the life of the reactor vessel head, without repair, is the propagation of a flaw on the ID of the penetration tube. Using methodology obtained from WCAP-14552, the shallow indications detected on the ID of the penetrations have been evaluated to determine the additional service life allowable before repair. The evaluation determined an allowed operating time of 5.6 years for penetrations 51 and 62 and 8.1 years for penetration 63 with the indications noted above on the ID of these penetrations. Periodic inspection of the indication during refueling outages will monitor potential growth of the indication and prevent compromising the structural integrity of the pressure boundary.