VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

October 5, 1995

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

Serial No. 95-465
NL&OS/JBL R4
Docket Nos. 50-280
50-281
50-338
50-339
License Nos. DPR-32
DPR-37
NPF-4
NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
NORTH ANNA POWER STATION UNITS 1 AND 2
RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION
REGARDING OUR RESPONSE TO GENERIC LETTER 95-03
CIRCUMFERENTIAL CRACKING OF STEAM GENERATOR TUBES

By letter dated April 28, 1995, the NRC issued Generic Letter 95-03, "Circumferential Cracking of Steam Generator Tubes," notifying addressees about the safety significance of recent steam generator tube inspection findings. Virginia Electric and Power Company responded to the generic letter for Surry and North Anna Power Stations by letter dated June 27, 1995. Most recently, by letter dated August 30, 1995, the NRC staff requested additional information regarding the steam generator tube examination plans and susceptibility of circumferential cracking at Surry and North Anna. The attachment to this letter provides the requested information.

If you have any further questions, please contact us.

Very truly yours,

R F Saunders for

James P. O'Hanlon
Senior Vice President - Nuclear

Attachment

100078

A001

cc: U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N.W.
Suite 2900
Atlanta, Georgia 30323

Mr. M. W. Branch
NRC Senior Resident Inspector
Surry Power Station

Mr. R. D. McWhorter
NRC Senior Resident Inspector
North Anna Power Station

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by R. F. Saunders, who is Vice President - Nuclear Operations, for J. P. O'Hanlon who is Senior Vice President - Nuclear, of Virginia Electric and Power Company. He is duly authorized to execute and file the foregoing document in behalf of that Company, and the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 5TH day of October, 1995.

My Commission Expires: May 31, 1998.

Vicki L. Hull
Notary Public

(SEAL)

ATTACHMENT

Response to NRC Request for Additional Information Regarding the Response to NRC Generic Letter 95-03 Circumferential Cracking of Steam Generator Tubes For Surry and North Anna Power Stations

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NRC Request:

1. **The following areas have been identified as being susceptible to circumferential cracking:**

   a. **Expansion transition circumferential cracking**
   b. **Small radius U-bend circumferential cracking**
   c. **Dented location (including dented TSP) circumferential cracking**
   d. **Sleeve joint circumferential cracking**

   In your response, area d was not specifically addressed. In addition, for areas b and c, design enhancements intended to reduce the potential for stress-related cracking of the replacement steam generators were referenced; however, specific plant conditions as a result of inspections were not addressed (e.g., denting is not expected as a result of the tube support plate design; however, the results from inspections which indicate that no denting has occurred were not provided). Please provide the requested information for these areas (and any other areas susceptible to circumferential cracking) per Generic Letter (GL) 95-03. The staff realizes that some of these areas may not have been addressed since they may not be applicable to your plant; however, this should be clearly stated with the basis for the statement (e.g., no sleeves are installed; therefore, the plant is not susceptible to sleeve joint circumferential cracking).

Response:

The NRC has identified four areas or regions of the steam generators where general PWR steam generator experience has indicated that tubes may be susceptible to circumferential cracking. These areas are:

A. Expansion transitions
B. Small radius U-bends
C. Dented locations (including dented tube support plate locations)
D. Sleeve joints

There has been no stress corrosion cracking, either axially or circumferentially oriented, identified in the Surry or North Anna steam generators. The Surry Units 1 and 2 steam generator tube inspection history includes several inspections using the RPC probe in the top of tubesheet region, where the tube to tubesheet expansion transition is located. For North Anna Units 1 and 2, the recent steam generator replacements also significantly reduces the probability of occurrence of circumferential cracking because of the short period of time the steam generators have been in service.

The following discussions are specific responses addressing the areas of the steam generators identified by the NRC as susceptible to circumferential cracking.

A. Expansion transitions. The manufacturing techniques and the materials selected for use in fabrication of the Surry and North Anna replacement steam generators should preclude initiation and rapid progression of degradation in the expansion transition area. This is concluded for several reasons:

1. For Surry, thermally treated Alloy 600 tubing has been shown to provide a substantial increase in the resistance to corrosion compared to mill annealed tubing. For North Anna, thermally treated Alloy 690 tubing has been shown to provide a substantial increase in the resistance to corrosion compared to mill annealed tubing and compared to Alloy 600 thermally treated tubing. This is indicated both from test reports and operating plant experience.

2. The residual stresses in the tube to tubesheet hydraulic expansion transition region used in the Surry and North Anna replacement steam generators are lower than other tube expansion techniques.

As delineated in our initial response to GL 95-03, the current Surry steam generator inspection program includes a sample of tubes in the top of tubesheet region using the RPC probe. To date, there has been no stress corrosion cracking identified in this region of the steam generators. These inspection results are consistent with industry experience.

A top of tubesheet inspection program has not been performed for the North Anna replacement steam generators. However, as stated in our initial response to GL 95-03, North Anna Units 1 and 2 plan to examine the top of tubesheet region in a sample of tubes using the RPC probe during the next refueling outages.

B. Small radius U-bends. The manufacturing techniques and the materials selected for use in fabrication of the Surry and North Anna replacement steam generators should preclude initiation and rapid progression of degradation in the small radius U-bend region of the steam generators. This is concluded for several reasons:

1. For Surry, thermally treated Alloy 600 tubing has been shown to provide a substantial increase in the resistance to corrosion compared to mill annealed tubing. For North Anna, thermally treated Alloy 690 tubing has been shown to provide a substantial increase in the resistance to corrosion compared to mill annealed tubing and compared to Alloy 600 thermally treated tubing. This is indicated both from test reports and operating plant experience.

2. The tubes in Rows 1 through 8 of the Surry and North Anna steam generators received a supplemental thermal treatment (stress relieving) after bending, while still in the manufacturing facility. The residual stresses in the Row 1 and 2 U-bends (where history has shown a degradation potential in mill annealed tubing) is therefore greatly reduced. Westinghouse evaluation has previously established that the expected residual stresses in this region are effectively reduced to below 15 ksi. Industry experience has noted only a limited number of incidences of degradation in tubing that has been stress relieved after bending, even in mill annealed tubing.

3. Also, starting with the Model F steam generators, which preceded the manufacture of the Surry replacement units, a set of U-bend manufacture geometric controls were implemented which included strict ovality, U-bend to leg flatness, and leg spacing requirements. These improved manufacturing requirements help to provide for consistent U-bends, which in turn translates to consistent stresses. The geometric controls help to eliminate localized stress discontinuities.

4. The current Surry steam generator inspection program includes a 9% sample of the top of tubesheet region using the RPC probe. No degradation has been found to date. The residual stresses in the tube to tubesheet hydraulic expansion transition region have been estimated to be as high as 40 ksi. The lack of degradation in this region suggests that other areas of the tube, operating at lower residual stress and lower temperatures (such as the small radius U-bend region), would be even less likely to exhibit degradation.

5. In 1988, a sample of the Surry Unit 1 small radius U-bends were inspected using the RPC probe. No degradation was detected.

Based on the above arguments, it is unlikely that structurally significant stress corrosion cracking is occurring in the Row 1 and 2 U-bends of the Surry and

North Anna steam generators and that, if degradation were to occur in this area, it would not be expected to rapidly propagate. Hence, Surry and North Anna have no plans to perform supplemental RPC tube examinations in the small radius U-bend region of the steam generators.

C. Dented locations (dented TSP locations). Construction of the Surry and North Anna replacement steam generators utilized stainless steel tube support plates with quatrefoil broached tube holes. This feature should preclude denting at the tube support plate intersection, since the denting phenomena is attributed to corrosion of carbon steel tube support plates. The quatrefoil broached tube holes provide for excellent flushing capabilities between the tube and tube support plate, further limiting the potential for corrosion in this region.

Based on inservice inspections of steam generator tubes at Surry Units 1 and 2 and North Anna Unit 1 and preservice inspection of the steam generator tubes at North Anna Unit 2, denting is not a concern. A very small number of eddy current responses in the Surry Units 1 and 2 and North Anna Unit 1 steam generators have been classified as "dents" by the analysts. However, the large majority of these signals are not associated with either a tube support plate or top of tubesheet. Rather, they are located in the free span region of the tubes. Thus, Surry and North Anna have no plans to perform an augmented RPC program aimed at this very small group of "dents."

D. Sleeve joints. The Surry and North Anna steam generators do not contain sleeves. Therefore, Surry and North Anna steam generators are not susceptible to sleeve joint circumferential cracking.

NRC Request:

2. Please provide the expansion criteria to be used if circumferential indications are detected at the expansion transition during the North Anna and Surry steam generator inspections.

Response:

Surry Power Station. As stated in the response to Generic Letter 95-03, Surry plans to continue with the top of tubesheet inspection program. This inspection will include examination of 301 tubes in the inspected steam generator during the current refueling outage for Unit 1 and during the next refueling outage for Unit 2. In the event a circumferentially-oriented defect is identified in the initial sample of tubes, the inspection will be expanded to include examination of an additional 602 tubes in the expansion transition region of the inspected steam generator. The extent of further expansion, if necessary, will be based on the results of the examined tubes.

North Anna Power Station. As stated in the response to Generic Letter 95-03, North Anna plans to conduct a top of tubesheet inspection program during the next refueling outage for each unit. This inspection will include examination of 324 tubes using examination techniques and equipment capable of detecting circumferentially-oriented indications in the expansion transition region. In the event a circumferentially-oriented defect is identified in the initial sample of tubes, the inspection will be expanded to include examination of an additional 648 tubes in the expansion transition region of the inspected steam generator. The extent of further expansion, if necessary, will be based on the results of the examined tubes.