VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

October 16, 2002

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

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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION
STEAM GENERATOR INSERVICE INSPECTION REPORT

By letter dated February 28, 2002, Virginia Electric and Power Company (Dominion), submitted the North Anna Power Station, Units 1 and 2, "Annual Steam Generator In-service Inspection Summary Report" to the NRC. In a letter dated October 4, 2002, additional information was requested by the NRC in order to complete their review and assessment of the subject report. The attachment to this letter provides the requested information.

No new commitments are being made as a result of this letter. If you have any questions or require further information, please contact us.

Very truly yours,

Stephen P. Sarver, Director
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Attachment

A047

cc: U.S. Nuclear Regulatory Commission
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ATTACHMENT

Request for Additional Information
Steam Generator Inservice Inspection Report

REQUEST FOR ADDITIONAL INFORMATION

NORTH ANNA POWER STATION, UNITS 1 AND 2

STEAM GENERATOR INSERVICE INSPECTION SUMMARY REPORT

Question 1:

Please describe the basic design of the North Anna Power Station, Units 1 and 2 steam generators including information such as tube diameter (e.g., 7/8-inch), tube wall thickness (e.g., 0.050-inch), number of tubes (e.g., 3592), tube expansion method (e.g., hydraulic), tube support design (support plates and antivibration bars), tube pitch, etc.

Please include a sketch of the tube support plate naming convention and a tubesheet map in this description.

Response:

Pertinent design information for the replacement North Anna steam generators is as follows: (Note that the replacement included the lower shell only)

Tube Features – 7/8" outside diameter, 0.050" wall, Alloy 690 thermal treated, 3592 tubes/generator, Westinghouse 3-loop

Support Plate Features – 405 Stainless Steel, broached tube hole openings, 1-1/8" nominal thickness, seven (7) full support plates with additional partial plate (i.e. baffle plate) between the 1st support plate and the tubesheet

Other Design/Fabrication Enhancements – Tube rows 1-8 U-bend sections were stress relieved after bending, full depth hydraulically expanded tube-to-tubesheet joints, and controlled tolerance anti-vibration bar (AVB) tube-to-bar gaps

Attached are selected figures from the steam generator technical manual that provide pertinent physical information requested and are delineated as follows:

- Figure 1-3, Tubesheet tube hole pattern, tube numbering, and tube pitch
- Figure 1-8, Tube support plate (TSP) location and designation (Note: Typically the support locations are referred to by number. Plate A is referred to as the baffle plate with Plate B being the first full tube support plate i.e., TSP 1)
- Figure 1-9, General TSP configuration for each plate
- Figure 1-10, General arrangement and configuration for AVBs

Question 2:

It was indicated that two techniques were used in sizing the indication found in steam generator C of North Anna, Unit 2 in Row 43, Column 56. Discuss whether the qualification data had indications that were observed at this location. Discuss whether

any other diagnostic exams besides eddy current testing were performed on this tube (e.g., ultrasonic testing, visual, in-situ pressure testing).

The indication in this tube was located within the confines of the tube support plate (presumably during shutdown) and was believed to be mechanically induced. Discuss whether the indication would be expected to be within the tube support plate during normal operation. If not, discuss the effects on your operational assessment/root cause investigation.

One possible cause for this indication was that it was a result of a burr or some other small discrete particle located at the edge of one of the quatrefoil lands. Discuss whether any scratches or manufacturing burnishing marks are located on the portions of this tube below the 5th cold-leg tube support.

In assessing the growth rate of this indication, it was assumed that the indication initiated immediately upon placing the replacement steam generators in service. In the licensee's 2000 Annual Report, it was indicated that antivibration bar wear indications in earlier F-type steam generators typically begin during the 4th to 5th cycle of operation. Given the potential for wear-type indications not to initiate immediately upon start-up, discuss the basis for the assumption that this indication initiated at start-up.

Response:

Review of information from the EPRI qualification indicates that the referenced bobbin technique data set contained thirty-three (33) sample indications of volumetric wear that were located at tube supports. The depths of the indications in the data set ranged from 4% to 78% of the tube wall thickness based upon the metallurgical results. The pancake probe qualification data set included volumetric samples (chemically induced pits) ranging in depth from 16% to 77% of the tube wall thickness. The indication on tube R43-C56 of the Unit 2 "C" steam generator was sized with two industry qualified techniques that most closely matched the eddy current signature and physical location within the steam generator. The most conservative value for indicated through wall (TW) was chosen to provide a conservative evaluation in the condition assessment.

Only routine diagnostic exams were conducted on this tube based on the type and size of the indication as determined by bobbin and rotating probe exams. The rotating probe follow-up examination confirmed the conclusions from the bobbin examination that no cracking degradation existed.

During normal operating conditions, especially during startup and shutdown transients, some minimal movement of the support plate is to be expected. Therefore, some relative movement of the support plate with respect to the tube is normal. The amount of movement under these conditions is not typically provided in the design report since it addresses various movement and stress details for design basis accident bounding conditions. It should be noted that with a broached tube support plate, the lands do not provide any assumed structural enhancement with respect to any potential tube degradation condition (i.e., it is considered the same as a free span and structural concerns would be dictated by DP conditions only).

No other anomaly signals, dents buff marks or indications were identified in the area adjacent to the 5th support or any other area on the inspected tube length.

As previously stated the noted indication was not at an AVB location and; therefore, may not exhibit the "growth" characteristics of a wear indication at an AVB intersection. To date no tube wear at AVB locations has been identified on either unit with Unit 1 having an operating time in excess of seven effective full power years (EFPY) at the last inspection in the Fall of 2001. No tube wear indications at AVB locations were identified during the recent Unit 2 inspection in the Fall of 2002. This would indicate stable conditions during normal operation and better performance than some of the earlier replacement and original equipment A-600TT tubed units with respect to this wear condition. Some later replacement A-690TT tubed units manufactured by B&W Canada have experienced some limited degradation during the early cycles of operation. This has not been the case with the Westinghouse manufactured units, such as North Anna.

Wear indications or indications of volumetric wall loss are typically not identified within the tube support plate locations, and this instance is the only case ever noted during the North Anna inspections. Hence, an investigation with respect to the reported indication was initiated to determine the characteristics and size of the wall loss and to evaluate the potential applicability on uninspected tubes and their associated condition assessment. Discussions relative to findings and discussions of augmented inspection actions were previously included in the annual report. With respect to growth rate considerations, Dominion's primary concern was to provide an assessment of potential conditions during the next cycle on uninspected tubes. No "growth rate" evaluation was conducted on tube R43-C56 for the purposes of leaving it in service. This tube was plugged. Using an assumption of "growth" from initial startup was judged to be reasonable, based on the assumption that a small manufacturing burr or the like would not have had an effect on the tube until unit operation. Therefore, no indication or anomaly was reported during the baseline inspection. Using the "C" steam generator indication as a basis, this results in an average growth rate of 5.66%/EFPY from initial startup to the subject inspection. Assuming this growth rate on an undetected indication in the "A" steam generator from steam generator replacement at the end of cycle 5 until September 2002, tube wear at this location would be projected as 49.2% through-wall (TW).

If a similar indication was assumed to have initiated at a later time, a more conservative "growth" could be derived. Since a 50% inspection was conducted on "A" steam generator in 1998 with no such indications identified, it could be conservatively assumed that an indication of this nature did not exist at that time. Assuming a similar undetected indication occurred in the "A" steam generator at a later time, wear growth derived from this assumption would result in an average growth rate of 30%/2.7 EFPY or 11.1%/EFPY. Assuming an additional cycle run until September 2002 and including appropriate eddy current uncertainties, tube wear would be projected as 52.4%TW. Both of these cases indicate a TW result less than the conservative 3 times differential pressure structural limit of 58%TW.

The recently completed inspection on Unit 2 "A" steam generator did not identify any such indications as found in tube R43-C56 in the "C" steam generator. This continues to confirm that such an indication is an isolated event. The September 2002 inspection

completes the uninspected 50% of the "A" steam generator tubes since the baseline exam.

Question 3:

Please clarify what is meant by "close gap antivibration wear tolerance techniques." Refer to page 5 of 7 of Attachment 1 to the February 28, 2002 submittal.

Response:

This term should read as follows as stated in the report:

"close gap anti-vibration bar tolerance techniques"

This refers to the process by which during the manufacture of the steam generators the anti-vibration bar (AVB)-to-tube gaps were closely controlled and monitored. The shop procedures covered insertion, alignment, and welding to provide for minimum clearance while avoiding compressive loading on the tubes. This process was applied to both Units 1 and 2. After completion of the installation and measurement process, the shop readings were reviewed by engineering to validate expected flow induced vibration conditions and that expected conditions would continue to meet design assumptions. The Westinghouse design report stated that "Potential tube wear depths are shown to be within design margins for wear depth for all expected fit-up conditions. Postulated conditions to cover a small percentage of statistically rare fit-up conditions, and potential uncertainties in material wear coefficients and tube/support interaction work-rates, are also evaluated and shown to be within design limits."