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January 31, 2011

Mr. David A. Heacock
President and Chief Nuclear Officer
Virginia Electric and Power Company
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: SURRY POWER STATION, UNIT NO. 1 (SURRY 1), REVIEW OF THE STEAM GENERATOR TUBE INSERVICE INSPECTION (ISI) REPORT FOR THE 2009 REFUELING OUTAGE (TAC NO. ME2898)

Dear Mr. Heacock:

By letter dated November 4, 2009 (Agencywide Documents Access and Management System (ADAMS), Accession No. ML093200207), Virginia Electric and Power Company (the licensee) submitted steam generator tube inspection results from the 2009 inspections at Surry 1. The licensee provided additional information in a letter dated June 7, 2010 (ADAMS Accession No. ML101660088). Additionally, by letter dated September 16, 2009 (ADAMS Accession No. ML091950409), the U.S. Nuclear Regulatory Commission (NRC) documented conference calls between the NRC staff and Surry 1 representatives on April 29 and May 1, 2009.

The NRC staff has completed its review of these reports and concludes that the licensee provided the information required by their technical specifications and that no additional follow-up is required at this time.

Sincerely,

Karen Cotton, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-280

Enclosure:
ISI Report

cc w/encl: Distribution via Listserv

REVIEW OF THE 2009 STEAM GENERATOR TUBE

INSERVICE INSPECTION REPORT

SURRY POWER STATION, UNIT NO. 1

DOCKET NO. 50-280

By letter dated November 4, 2009 (Agencywide Documents Access and Management System (ADAMS), Accession No. ML093200207), Virginia Electric and Power Company (the licensee) submitted steam generator (SG) tube inspection results from the 2009 inspections at Surry Power Station, Unit No. 1 (Surry 1). The licensee provided additional information in a letter dated June 7, 2010 (ADAMS Accession No. ML101660088). Additionally, by letter dated September 16, 2009 (ADAMS Accession No. ML091950409), the U.S. Nuclear Regulatory Commission (NRC) documented conference calls between the NRC staff and Surry 1 representatives on April 29 and May 1, 2009.

Surry 1 has three SGs that were replaced in 1981. The replacement SGs were fabricated by Westinghouse. Each SG nominally contains 3,342 thermally treated Alloy 600 tubes. Each tube has a nominal outside diameter of 0.875 inches and a nominal wall thickness of 0.050 inches. The tubes were hydraulically expanded at both ends for the full length of the tubesheet and are supported by a number of stainless steel tube support plates (TSPs). The U-bends of the tubes installed in rows 1 through 8 were thermally stress-relieved after bending.

The licensee provided the scope, extent, methods, and results of their SG tube inspections in the documents referenced above. In addition, the licensee described corrective actions (e.g., tube plugging) taken in response to the inspection findings.

After review of the information provided by the licensee, the NRC staff has the following comments/observations:

- The licensee provided condition monitoring (CM) graphs for part through-wall volumetric indications for the 2009-outage inspections. These graphs plotted the length and depth of the volumetric indications (as measured by eddy current) against the CM curves that were developed by accounting for and combining uncertainties, including sizing uncertainties, using Monte Carlo techniques, except for one tube that used the structurally significant depth and axial length (instead of the as-measured depth and length). The licensee stated that this was appropriate because both the measured and structurally significant depths and lengths were acquired with the same eddy current process. Although acquired with the same process, it was not clear to the NRC staff that the uncertainty associated with determining the maximum depth or length of the flaw is the same as the uncertainty associated with determining the structurally significant depth and length of a flaw. Nonetheless, the NRC staff notes that had the as-measured depth and length been plotted in Figure 1 (instead of the structurally significant depth and length), the flaw would have still been acceptable from a CM standpoint.

- An axial indication attributed to primary water stress corrosion cracking (PWSCC) was detected in the portion of the tube at the top of the tubesheet on the hot-leg side of the SG. This indication was estimated to be approximately 0.64 inches long and 0.32 inches above the top of the tubesheet (TTS). Portions of the indication were estimated to be 100-percent through wall. This tube was considered a tier 1 tube (i.e., it contained a unique offset in the eddy current data on both the hot- and cold-leg sides of the u-bend). The NRC staff reviewed the 2006 and 2009 eddy current data for this tube. In 2006, only bobbin coil data was obtained. In 2009, both bobbin coil and rotating probe data was obtained. The bobbin coil data was evaluated by the licensee using a turbo mix to reduce the effect of the tubesheet, expansion transition, and other interfering effects at this location. The NRC staff concluded that there was a flaw-like signal at the top of the tubesheet in 2009; however, a flaw at this location was not readily detectable in the 2006 bobbin data. This latter conclusion was based, in part, on the size of the mix residuals at the top of the tubesheet. The flaw in this tube appears to have initiated from the inside diameter of the tube. An inspection with a smaller coil operated at a higher frequency would most likely result in a higher probability of detecting similar type flaws.

- Crack-like indications were found near the tube ends in all three SGs. Additionally, large permeability variations were found near many of the tube ends in SG B.

- At the TTS on the hot-leg side in SGs A and C, a rotating probe was used to inspect:

  (1) approximately 58 percent of the tubes from 3 inches above to 3 inches below the TTS,

  (2) all tier 1 tubes from the tube end to 3 inches above the TTS, and,

  (3) 20 percent of the tier 2 tubes (i.e., a unique offset in either the hot- or cold-leg side of the U-bend, but not both) from the tube end to 3 inches above the TTS.

At the TTS on the hot-leg side in SG B, a rotating probe was used to inspect all tier 1 tubes from the tube end to 3 inches above the TTS and all tier 2 tubes from 3 inches above to 3 inches below the TTS (with 20 percent of these tubes being inspected from the tube end to 3 inches above the TTS). The licensee focused some of their TTS exams on tier 1 and tier 2 tubes, in part, because of the detection of the PWSCC flaw (discussed above) in a tier 1 tube in SG A. Once a crack is detected, most plants inspect 100 percent of the potentially affected population of tubes to ensure tube integrity is maintained. With respect to whether the PWSCC flaws observed at Surry 1 are limited to tier 1 and 2 tubes, the NRC staff observed the following:

  - Industry analysis indicates the screening for eddy current offsets is applicable only to the straight length of tubes above the TTS and that it is not intended to address PWSCC.

- The NRC staff is unaware of any conclusive data that TTS cracking at other plants is preferentially associated with offset tubes (i.e., cracking at the TTS may be driven more by the residual stresses associated with the expansion process rather than by the offset).

- The bobbin coil will not detect circumferential cracking.

- Cracking in offset tubes at other plants has primarily been outside diameter initiated rather than inside diameter initiated, and a 60-percent sample may not be sufficient to detect all cracks.

- The licensee used the Post Deposit Minimization Treatment (PDMT) to reduce the inventory of deposit material on the secondary side of the SG and to reduce the potential for tube corrosion, TSP broach-hole blockage, and steam pressure loss due to heat transfer surface fouling. The DMT process uses a low concentration of oxalic acid to remove iron oxide deposits and both oxalic acid and hydrogen peroxide as a final passivation step. The DMT process removed approximately 2200 pounds of iron oxide from the secondary side of the SGs.

- The licensee stated that they performed secondary side inspections in SG A, including the upper two steam drum decks, the primary and secondary separators, the swirl vanes, drain pipes, deck attachment welds, and ladders, which were all found to be acceptable. A portion of the SG A upper bundle was inspected through three primary swirl vanes after the DMT process. This inspection showed that deposit loading on the tubes, anti-vibration bars (AVBs), and AVB/tube intersections had been reduced by the DMT process, and a decrease in the amount of deposits in the broached openings of the 6th and 7th TSPs. The SG A J-nozzle-to-feedring interfaces were visually inspected and minor flow accelerated corrosion was observed.

- A couple pit-like indications were detected in SG A and not plugged during the 2009 outage (the pit-like indications had been detected in prior outages as well). No tubes were pulled to confirm the nature of these indications; instead, the licensee relied on knowledge gained from prior tube pulls (presumably from other facilities), ultrasonic testing, and rotating probe data from similar indications to characterize these indications as "pit-like." In an August 23, 1999 (ADAMS Legacy Accession No. 9908300113), letter to Mr. J. P. O'Hanlon, the NRC staff concluded that the licensee had an inadequate technical basis for assuming suspected pit indications were representative of actual pitting. As a result, the NRC staff concluded that a pitting technique to estimate the depth of these indications was inappropriate. The NRC staff is not aware of any additional information that would change the basis for its original conclusion that there is an inadequate technical basis for leaving these indications in service. The indications, however, do not appear to be growing and are stable during normal operation.

Based on a review of the information provided by the licensee, the NRC staff concludes that the licensee provided the information required by their technical specifications. The SG tube inspections at Surry 1 appear to be consistent with the objective of detecting potential tube degradation and the inspection results appear to be consistent with industry operating experience

at similarly designed and operated units (with the possible exception of the pit-like indications). The NRC staff will consider obtaining a better understanding of the licensee's basis for leaving these indications in service during a subsequent inspection of these steam generators.

Principal Contributor: A. Johnson

Date: January 31, 2011

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/RA by VSreenivas for/

Karen Cotton, Project Manager
Plant Licensing Branch II-1
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Office of Nuclear Reactor Regulation

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