

February 12, 2008

Mr. David A. Christian
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 NOS. 1 AND 2, REVIEW OF THE 2006
REFUELING OUTAGE STEAM GENERATOR TUBE INSERVICE INSPECTION
REPORTS (TAC NOS. MD4651 AND MD4652)

Dear Mr. Christian:

By letters dated June 1, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML061520302), November 30, 2006 (ADAMS Accession Number ML063340555), March 1, 2007 (ADAMS Accession Number ML070650263), and August 10, 2007 (ADAMS Accession Number ML072280196), Virginia Electric and Power Company (the licensee) submitted steam generator (SG) tube inspection results from the 2006 inspections at Surry Power Station, Unit Nos. 1 and 2 (Surry 1 and 2). In addition to these reports, the Nuclear Regulatory Commission (NRC) staff summarized additional information concerning the 2006 SG tube inspections at Surry 1 in a letter dated December 4, 2006 (ADAMS Accession Number ML063380371) based on the two conference calls held between the NRC staff and Surry 1 representatives on May 10, and May 11, 2006.

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. The NRC staff's review of the reports is enclosed.

Sincerely,

/RA/

Siva P. Lingam, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-280 and 50-281

Enclosure:
Inspection Summary Report

cc w/encl: See next page

February 12, 2008

Mr. David A. Christian
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 NOS. 1 AND 2, REVIEW OF THE 2006
REFUELING OUTAGE STEAM GENERATOR TUBE INSERVICE INSPECTION
REPORTS (TAC NOS. MD4651 AND MD4652)

Dear Mr. Christian:

By letters dated June 1, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML061520302), November 30, 2006 (ADAMS Accession Number ML063340555), March 1, 2007 (ADAMS Accession Number ML070650263), and August 10, 2007 (ADAMS Accession Number ML072280196), Virginia Electric and Power Company (the licensee) submitted steam generator (SG) tube inspection results from the 2006 inspections at Surry Power Station, Unit Nos. 1 and 2 (Surry 1 and 2). In addition to these reports, the Nuclear Regulatory Commission (NRC) staff summarized additional information concerning the 2006 SG tube inspections at Surry 1 in a letter dated December 4, 2006 (ADAMS Accession Number ML063380371) based on the two conference calls held between the NRC staff and Surry 1 representatives on May 10, and May 11, 2006.

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. The NRC staff's review of the reports is enclosed.

Sincerely,

/RA/

Siva P. Lingam, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-280 and 50-281

Enclosure:
Inspection Summary Report

cc w/encl: See next page

DISTRIBUTION: Public
LPL2-1 R/F
RidsNrrDorlLpl2-1 (MWong)
RidsNrrPMSLingam (hard copy)
RidsRgn2MailCenter (EGuthrie)
RidsNrrDciCsgb (AJohnson)
RidsNrrLAMO'Brien (hard copy)
RidsOgcRp
RidsAcrcAcnwMailCenter
RidsNrrDciCsgb (AHiser)
RidsNrrDciCsgb (KKarwoski)

ADAMS Accession No. ML080390325

*transmitted by memo dated

OFFICE	NRR/LPL2-1/PM	NRR/LPL2-1/LA	NRR/DCI/CSGB/BC	NRR/LPL2-1/BC (A)
NAME	SLingam	MO'Brien	AHiser	MWong
DATE	2/7/08	2/11/08	2/6/08*	2/12/08

OFFICIAL RECORD COPY

REVIEW OF THE 2006 REFUELING OUTAGE
STEAM GENERATOR TUBE INSPECTION REPORTS
VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION, UNIT NOS. 1 AND 2
DOCKET NOS. 50-280 AND 50-281

By letters dated June 1, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession Number ML061520302), November 30, 2006 (ADAMS Accession Number ML063340555), March 1, 2007 (ADAMS Accession Number ML070650263) and August 10, 2007 (ADAMS Accession Number ML072280196), Virginia Electric and Power Company (the licensee) submitted steam generator (SG) tube inspection results from the 2006 inspections at Surry Power Station, Unit Nos. 1 and 2 (Surry 1 and 2). In addition to these reports, the Nuclear Regulatory Commission (NRC) staff summarized additional information concerning the 2006 SG tube inspections at Surry 1 in a letter dated December 4, 2006 (ADAMS Accession Number ML063380371) based on the two conference calls held between the NRC staff and Surry 1 representatives on May 10, and May 11, 2006.

Surry 1 and 2 have three SGs in each unit, and these SGs were replaced in 1981 and 1980, respectively. 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. 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 following comments/observations apply to Surry 1 and 2:

- Several anti-vibration bar wear indications were detected in prior outages (2001 for Unit 1 and 2002 for Unit 2), but not reported in the 2006 outage because the tubes containing the indications were either plugged during the previous outages or the indication was slightly below the 10% through-wall reporting criteria in the 2006 outage.

- In their report, the licensee provided several Condition Monitoring (CM) graphs that reported non-anti-vibration bar wear measurement indications from the 2006 outage inspections. Some of these graphs plotted “structurally significant flaw depth” against “structurally significant flaw length.” In the context of these graphs, “structurally significant” refers to crack dimensions that are determined by a flaw profiling evaluation. The flaw profiling evaluation attempts to correlate a measured crack size to a known crack size that has been tested in a laboratory. In the report, the licensee stated that the CM curves on the graphs were adjusted to account for the uncertainty in sizing the flaws. Although the NRC staff did not review the development of the limits in these graphs in detail, NRC staff did ask the licensee to clarify how the graphs accounted for the uncertainties. In response, the licensee stated that the uncertainty adjustments in the condition monitoring limit curves were based on the actual flaw size dimensions in the qualification database, rather than on the “structurally significant” dimensions of the flaws (which are what is plotted in the graphs).
- In 2006, no rotating probe examinations were performed in the lower 2 inches of the tubes. The licensee did not consider an inspection in the bottom 2 inches necessary because the expected time to develop cracking in that region has not yet been reached given the low operating temperature at Surry 1 and 2 compared to other plants that have observed cracking in this region. The licensee also indicated that cracking was not observed in other locations within the tubesheet (e.g., overexpansions) as had been detected at another plant. The NRC staff agrees that with all other factors being equal, the lower the temperature the less likely cracking will occur. However, it is often difficult to demonstrate that all of the other factors are equal. This is supported by operating experience where certain regions of the tube (at cooler temperatures) may crack before similar but hotter locations. In addition, the NRC staff notes that the cracking observed away from the tube end at one plant was found in the same outage as the cracking at the tube end. As a result, it is not clear whether the cracks at the tube end initiated first or whether the cracking at the other location occurred first. In addition, there were many more indications near the tube end than in the upper portion of the tubesheet. These considerations, along with other factors, are important in developing an inspection strategy.
- A pattern of dents has been identified in peripheral tubes in steam generator C in Surry 1 and 2. These dents are located at the sixth and seventh tube support plates and are in peripheral tubes located near tube support wedge locations.
- In their letter dated August 10, 2007, the licensee references an “H*” evaluation that was used in support of their assessments of tube degradation within the tubesheet. The NRC staff notes that the inspection and repair criteria contained in the “H*” evaluation have not been approved by the NRC as a permanent amendment for any operating plant, but that some plants have received approvals to implement the “H*” criteria on a short-term basis.

The following comments/observations apply only to Surry 1:

- Of the 14 volumetric indications not attributed to anti-vibration bar wear, approximately five were detected with only the rotating probe (i.e., they were not detected with the bobbin probe). Most of these volumetric indications were attributed to wear from foreign objects/loose parts. Since two of these five indications exceeded the plugging limit (using

a sizing technique considered conservative by the licensee), the licensee expanded the scope of their rotating probe inspections at the top of the tubesheet to include an additional 20% of the tubes on both the hot- and cold-leg sides of the SG. Given these results, the NRC staff notes that similar wear indications could exist in other tubes not inspected with a rotating probe. The licensee's operational assessment for foreign object wear cites favorable past operating experience with foreign object wear, robust secondary side visual examinations (including the removal of all identified objects), and shorter operating intervals between inspections, for concluding there is reasonable assurance that tube integrity will be maintained until the next inspection. Although the licensee's conclusions may be appropriate, additional confidence that tube integrity will be maintained could be gained through additional rotating probe examinations near the top of the tubesheet and assessing the tube integrity implications of possibly having missed a foreign object wear indication (comparable in size to those detected during the outage) since there is operating experience that indicates that visual inspections are not always effective at identifying loose parts (and assuming that 100% of the surface area of the tubesheet was visually examined).

- Several pit-like indications were detected and not plugged during the 2006 refueling outage. 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, 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. The issue of leaving pit-like indications in service was subsequently discussed with the licensee during their fall 2007 inspection outage.
- The licensee has several tubes that were not expanded for the full length of the tubesheet (two tubes in steam generator A and seven tubes in steam generator C).
- No tubes in rows 1 through 8 in steam generators A or C have an eddy current offset that would be indicative of non-optimal tube processing. Nineteen large radius tubes (tubes in rows 9 or higher) in steam generator A and 3 large radius tubes in steam generator C may have higher residual stresses as a result of the fabrication process. Rotating probes were used to inspect various locations on some of these tubes and no degradation was identified.
- The tube in row 35 column 68 in steam generator A was subjected to a full tube length in-situ pressure test due to the size of the foreign object induced wear scar identified in the tube. During the in-situ test, a leak developed in this tube at a pressure of 4650 pounds per square inch. The maximum measured leak rate was 0.98 gallons per minute. Although the licensee concluded that the tube satisfied the structural integrity performance criteria, the NRC staff expressed concerns during a conference call on May 10, 2006, on whether or not the licensee adequately demonstrated that the tube had adequate integrity

since the leak rate was not stable at the time the test was concluded. Additional information is included in a letter to the licensee dated December 4, 2006 (ADAMS Accession No. ML063380371).

The following comments/observations apply only to Surry 2:

- Of the approximately 10 volumetric indications not attributed to anti-vibration bar wear, approximately six were detected with only the rotating probe (i.e., they were not detected with the bobbin probe). Most of these volumetric indications were attributed to wear from foreign objects/loose parts. The maximum depth associated with these indications was 36% through-wall (using a sizing technique considered conservative by the licensee). Since 100-percent of the tubes were not inspected with a rotating probe at the locations where these volumetric indications were detected, the NRC staff notes that similar wear indications could exist in other tubes not inspected with a rotating probe. The licensee's operational assessment for foreign object wear cites favorable past operating experience with foreign object wear, robust secondary side visual examinations (including the removal of all identified objects), and shorter operating intervals between inspections, for concluding there is reasonable assurance that tube integrity will be maintained until the next inspection. Although the licensee's conclusions may be appropriate, additional confidence that tube integrity will be maintained could be gained through additional rotating probe examinations near the top of the tubesheet and assessing the tube integrity implications of possibly having missed a foreign object wear indication (comparable in size to those detected during the outage) since there is operating experience that indicates that visual inspections are not always effective at identifying loose parts (and assuming that 100% of the surface area of the tubesheet was visually examined).
- The licensee has tubes that were not expanded for the full length of the tubesheet (two tubes in steam generator A).
- No tubes in rows 1 through 8 in steam generator A have an eddy current offset that would be indicative of non-optimal tube processing. No large radius tubes (tubes in rows 9 or higher) in steam generator A have higher residual stresses as a result of the fabrication process.
- During the visual examination of the hot-leg tube plugs, a yellow stain was discovered at the end of the tube in row 41 column 27 of steam generator A and on the upper channel head bowl. The hot-leg end of this tube had been inadvertently plugged during a 1986 outage and was de-plugged by drilling in 1991. It appears that the tube was drilled off-center during the plug removal process exposing the tubesheet for a circumferential distance of approximately 0.9-inches. No other Surry 2 steam generator tubes have been de-plugged. This tube was plugged during the 2006 refueling outage. In future inspections, the licensee will monitor this plug to ascertain whether significant tubesheet corrosion is occurring. Significant corrosion would be identified through corrosion product deposition on the end of the plug and/or as plug denting. Although the licensee determined that the channel head damage is acceptable for continued service without repair for the remaining licensed life of the unit, the licensee will continue to perform visual examinations of the channel head during outages in which work is performed on the primary side of the steam generator.

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. In general, the SG tube inspections at Surry 1 and 2 appear to be consistent with the objective of detecting potential tube degradation (except possibly in the tubesheet as discussed above) and the inspection results appear to be consistent with industry operating experience at similarly designed and operated units (except for the pit-like indications as discussed above).

Surry Power Station, Unit Nos. 1 & 2

cc:

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

Ms. Lillian M. Cuoco, Esq.
Senior Counsel
Dominion Resources Services, Inc.
Building 475, 5th Floor
Rope Ferry Road
Waterford, Connecticut 06385

Mr. Donald E. Jernigan
Site Vice President
Surry Power Station
Virginia Electric and Power Company
5570 Hog Island Road
Surry, Virginia 23883-0315

Senior Resident Inspector
Surry Power Station
U. S. Nuclear Regulatory Commission
5850 Hog Island Road
Surry, Virginia 23883

Chairman
Board of Supervisors of Surry County
Surry County Courthouse
Surry, Virginia 23683

Dr. W. T. Lough
Virginia State Corporation Commission
Division of Energy Regulation
Post Office Box 1197
Richmond, Virginia 23218

Dr. Robert B. Stroube, MD, MPH
State Health Commissioner
Office of the Commissioner
Virginia Department of Health
Post Office Box 2448
Richmond, Virginia 23218

Office of the Attorney General
Commonwealth of Virginia
900 East Main Street
Richmond, Virginia 23219

Mr. Chris L. Funderburk, Director
Nuclear Licensing & Operations Support
Dominion Resources Services, Inc.
Innsbrook Technical Center
5000 Dominion Blvd.
Glen Allen, Virginia 23060-6711