May 20, 2002

MEMORANDUM TO: File

FROM: Omid Tabatabai, Project Manager /***RA***/
License Renewal Section
License Renewal and Environmental Impacts Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

SUBJECT: DOMINION'S SUPPLEMENTAL RESPONSE TO RAI 4.3-6.

On April 22, 2002, Mike Henig of Virginia Electric and Power Company (VEPCo) transmitted an electronic mail (e-mail) to Omid Tabatabai and provided Dominion's supplemental response to the staff's request for additional information (RAI) 4.3-6. The e-mail response from VEPCo is attached.

Attachment: As Stated

cc: PUBLIC

Docket Nos. 50-338, 50-339, 50-280, and 50-281

Supplemental Information for RAI 4.3-6:

Charging and Safety Injection Nozzles:

The NAPS/SPS environmental fatigue calculations for the charging nozzle and the safety injection nozzle were performed by Structural Integrity Inc. using the detailed fatigue calculations contained in NUREG/CR-6260 for these two components for the Older Vintage Westinghouse plant. This was necessitated because SPS, being a B31.1-designed plant, had no explicit fatigue usage analyses performed for these components. Detailed fatigue analyses are not available for these locations for NAPS, but the CUF values were available from the stress reports. The CUF value for charging nozzle is 0.8646. The CUF values for the 6" safety injection nozzle and for 12" accumulator nozzle are 0.746 and 0.6846 respectively. The value of 0.746 was conservatively used for SI nozzle evaluation.

Since the detailed load pairings and fatigue evaluation that produced the NAPS fatigue usage values were not available, it was decided to apply the detailed fatigue evaluation for these locations found in NUREG/CR-6260, and scale up the alternating stress values from the NUREG/CR-6260 calculations to match the fatigue usage values for NAPS. In order to support such an application of the NUREG/CR-6260 results, three important verifications were considered necessary:

- The component materials for NAPS should match those for the NUREG/CR-6260 components.
- The component geometry for NAPS should be similar to those for the NUREG/CR-6260 components and, where necessary, size effects should be properly accounted for.
- The NAPS design transients should match or be bounded by the transients used in NUREG/CR-6260 both severity and number.

The above comparisons were made between the NAPS and NUREG/CR-6260 components. A comparison of the geometry between the NAPS, SPS, and NUREG/CR-6260 locations is given in Table 1.

The successful comparisons concluded that, if a similar analysis to that performed in NUREG/CR-6260 were performed for the NAPS components, similar load pairings would be achieved, but higher S_{alt} values would be needed to produce the higher NAPS fatigue usage values. Therefore, all S_{alt} values from NUREG/CR-6260 were scaled up by an equal percentage such that the resulting revised number of allowable cycles identically reproduced the NAPS fatigue usage values. Thus, in effect, the NAPS fatigue usage load pairings were reconstituted. This is shown in Step #2 of the tables included in the NAPS/SPS RAI responses for the charging inlet nozzle and safety injection nozzle locations. Note that Step #1 of the tables simply reproduces both the NB-3600 and NB-3200 calculations contained in NUREG/CR-6260.

In Step #3 of the tables in the NAPS/SPS RAI responses, a NB-3200 fatigue calculation is derived for NAPS. This is done by scaling the S_{alt} values from the reconstituted NB-

3600 calculation for NAPS by the ratio of the NB-3200 S_{alt} values from NUREG/CR-6260 divided by the NB-3600 S_{alt} values from NUREG/CR-6260.

In Step #4 of the tables in the NAPS/SPS RAI responses, an appropriate F_{en} multiplier was computed and applied to the fatigue usage derived for NAPS using NB-3200 methodology. For this calculation, a strain rate was computed based on the methodology documented in D. R. McNeill and John E. Brock, "Engineering Data File, Charts for Transient Temperatures in Pipes," Heating/Piping/Air Conditioning, Reinhold Publishing Corporation, pp. 107-119, November 1971. As stated on page 5-67 of NUREG/CR-6260, the dominant term in Equation (11) from the ASME Code NB-3600 piping equations is $K_3C_3E_{ab}|\alpha_aT_a - \alpha_bT_b|$, so this equation was used to determine a peak stress, and the Biot number formulations and charts of the McNeill-Brock publications, coupled with the component geometry and material properties, were used to determine the time at which the peak stress occurred. Together, these values were used to compute the strain rate (i.e., $\sigma/[Et]$).

The resulting fatigue usage (CUF), with F_{en} applied, represents the environmentally adjusted fatigue usage value for 60 years for NAPS. The CUF values for both components are seen to be less than the allowable value of 1.0, which is acceptable.

Table 1: Comparison of Affected Geometry for the Charging Inlet and Safety Injection Nozzles

Piping	Plant	Diameter	Thickness
Charging Line	North Anna	Nominal Diameter = 3”	0.4375”
Charging Line	NUREG-6260	Nominal Diameter = 3”	0.4375”
Charging Line	Surry	Nominal Diameter = 3”	0.4375”
Safety Injection	North Anna	Nominal Diameter = 6”	0.718”
Safety Injection	Surry	Nominal Diameter = 6”	0.562”
Safety Injection (Accumulator)	NUREG-6260	Nominal Diameter = 10”	1.000”
Safety Injection (Accumulator)	North Anna	Nominal Diameter = 12”	1.01”
Safety Injection (Accumulator)	Surry	Nominal Diameter = 12”	1.13”
Cold Leg	North Anna	ID = 27.5”	2.211”
Cold Leg	NUREG-6260	ID = 27.5”	2.375”
Cold Leg	Surry	ID = 27.5”	2.215”
Hot Leg	North Anna	ID = 29”	2.50”
Hot Leg	NUREG-6260	ID = 29”	2.50”
Hot Leg	Surry	ID = 29”	2.50”

Charging Lines – The transition regions of branch connections are fabricated to standard Westinghouse details. The nominal pipe sizes and schedules are the same at SPS, NAPS and the Older Vintage Westinghouse Plant evaluated in NUREG/CR-6260. Any differences are accommodated for by the scaling factor approach used since the NAPS plant-specific fatigue usage values were reproduced. Since the same transients apply to NAPS and SPS as were evaluated in NUREG/CR-6260, the load pairings for NAPS and SPS are expected to be similar to those established in NUREG/CR-6260.

Safety Injection Lines - The transition regions of branch connections are fabricated to standard Westinghouse details. Most of the stresses are due to thermal transient effects. Because of the higher CUF, six-inch SI line was used in calculation for the EAF effects. Although the line sizes used in the calculation for SI nozzle are smaller than those used in the Older Vintage Westinghouse plant in NUREG/CR-6260, the scaling factor approach used accommodates for this since the NAPS plant-specific fatigue usage values were reproduced. Since the same transients apply to NAPS and SPS as were evaluated in NUREG/CR-6260, the load pairings for NAPS and SPS are expected to be identical to those established in NUREG/CR-6260.

COMPARISON OF CHARGING AND SAFETY INJECTION NOZZLES:

The original design authority (Westinghouse) was requested to compare the configurations of the Charging and Safety Injection/Accumulator reactor coolant loop (RCL) nozzles of Surry and North Anna to those of Turkey Point, with respect to the applicability of evaluations performed in NUREG/CR-6260 to address reactor water environmental effects on fatigue. The comparisons were based on material and geometric effects on stresses that influence the fatigue evaluations of the controlling locations in the nozzles. The comparisons and assessments of these effects also included review of past finite element and fatigue calculations performed by Westinghouse, both generically and for North Anna.

The material properties of the Surry and North Anna nozzles are the same as those of the corresponding Turkey Point nozzles. Therefore, the influence of the material properties on stress and fatigue evaluations would be the same. The results for the geometrical comparison are discussed below.

CHARGING NOZZLE GEOMETRY EVALUATION:

1. Surry Charging Nozzles

The Surry 1 & 2 nozzles and the Turkey Point 4 nozzle were built to the same nozzle drawing. Hence, they are identical.

– Loop thicknesses are slightly different from Turkey Point, but the geometric discontinuity (t_a/t_b) at the branch is enveloped by Turkey Point.

Therefore, the NUREG/CR-6260 evaluation applies to Surry 1 & 2 charging nozzles.

2. North Anna Charging Nozzles

The North Anna 1 & 2 nozzles are somewhat different from Turkey Point.

Branch region:

– The nozzle reinforcement is thicker. However, this results in less discontinuity effect at the branch location.

– There is no thermal sleeve at NAPS. A review was made of the calculations performed by Westinghouse that supported justification of the removal of thermal sleeves, based on finite element analyses. From the results of these analyses, it was concluded that the safe end region governs for nozzles with and without a thermal sleeve, and that this conclusion applies to the 3” charging nozzle and 12” SI/Accumulator nozzles. This conclusion was based on the following:

- Removing the thermal sleeve reduces the temperature discontinuity, and thus reduces the resulting stress intensities and usage factor, at the nozzle end weld. Therefore, analyses of the nozzle end performed with the thermal sleeve in place are conservative and applicable to the nozzle without the sleeve for this location.

- Results for the branch of the nozzle without the sleeve are less severe than for the nozzle end weld.

Therefore, the North Anna nozzles’ branch region for charging nozzles is considered to be less severe than the safe end region. The comparison is controlled by the safe end.

Safe End Region:

– The differences between the safe end regions of the North Anna charging nozzles and of the Turkey Point nozzles are insignificant. The slightly thinner section (8%) will have negligible impact on the stresses. There is no significant structural discontinuity at the safe end of either design.

Transition Region:

– The thicker nozzle reinforcement and larger transition angle (45º vs. 30º) of the North Anna nozzles results in a greater structural discontinuity effect. However, the transition discontinuity is somewhat removed from the immediate area of the region “above the thermal sleeve” in the Turkey Point model. The thermal sleeve in the Turkey Point model also introduces thermal discontinuity that will not exist in the North Anna nozzles without a sleeve. Finally, the North Anna charging nozzles with a 45º transition angle were evaluated for fatigue by demonstrating conformance to a generic model and updating load combinations for different moment loads. The generic model used in the conformance evaluation had a transition geometry with a t_b closer to that of Turkey Point. This means that the model applicable for the North Anna nozzle qualification was similar to the Turkey Point model in this region.

SI/ACCUMULATOR NOZZLE GEOMETRY EVALUATION:

1. Surry SI/Accumulator Nozzles

The Surry 1 & 2 nozzles are 12”-140 vs. 10”-140 on Turkey Point. The 10”-140 nozzle evaluation is applicable to the 12”-140 nozzles for the following reasons.

<u>Branch region:</u>

– The nozzle reinforcement is thicker. However, this results in less discontinuity effect for the branch location. Since there is a thermal sleeve, the discontinuity effect (vs. through wall effect) will control the stresses in the nozzle reinforcement region. Therefore, the NUREG/CR-6260 evaluation is representative, if not conservative.

<u>Safe End Region:</u>

– The safe end region of the Surry SI nozzle is only about 13% thicker than Turkey Point. This will have a negligible impact on through wall stress. This is reinforced by the fact that Westinghouse generic analyses were done for 10”-140 nozzles, and were applied to both 10”-140 and 12”-140 nozzles for plant specific fatigue conformance evaluations, including those done for North Anna 12”-140 nozzles. In addition, the discontinuity effect is close to that of Turkey Point 3, and enveloped by Turkey Point 4. Therefore, the NUREG/CR-6260 evaluation is representative.

<u>Transition Region:</u>

– The through wall effect at the transition is the same as for the safe end, and the effect on stress remains negligible. The discontinuity effect at the transition is only 5% more than Turkey Point, which will also have an insignificant impact on the stresses. Given the margin in the NUREG/CR-6260 results after accounting for environmental effects, it can be concluded that the NUREG results are applicable for the Surry nozzles.

2. North Anna SI/Accumulator Nozzles

Similar to Surry, the North Anna 1 & 2 nozzles are also 12”-140 vs. 10”-140 for Turkey Point. However, the nominal thickness in the unreinforced region is the same for both. Identified above, the analysis for 10”-140 nozzle is applicable to North Anna nozzles for the following reasons.

<u>Branch region:</u>

– The nozzle reinforcement is thicker. This results in less discontinuity effect for the branch location, thus reducing the resulting stress intensities and usage factor.

– There is no thermal sleeve at NAPS. As discussed above, the safe end region governs for these nozzles, with or without a thermal sleeve.

Therefore, the North Anna nozzles’ branch region is considered to be less severe than the safe end region. The comparison is controlled by the safe end.

<u>Safe end region:</u>

- The through-wall thickness of the safe end is similar to Turkey Point, due to the larger ID of the North Anna nozzles. The relative geometric discontinuity of North Anna 1 is only 5% more than Turkey Point, which will have negligible impact on stress. The relative geometric discontinuity of North Anna 2 is less than Turkey Point. Therefore, the North Anna model is similar to the Turkey Point model.

<u>Transition region:</u>

- The thicker nozzle reinforcement and larger transition angle (45º vs. 30º) of the North Anna nozzles results in a greater structural discontinuity effect. However, the transition discontinuity is more removed from the immediate area of the region at the pipe weld, which controls in the Turkey Point model. This also controls in the North Anna model. The thermal sleeve in the Turkey Point model also introduces thermal discontinuity that will not exist in the North Anna nozzles without a sleeve. Either the thicker section or the thermal sleeve produces a thermal discontinuity stress because of the differential growth of the adjacent parts. Based on the loading and boundary conditions, it is concluded that more thermal discontinuity would result from the thermal sleeve shielding than from the unshielded thicker section. It can then be concluded that the net effect on stress of transition region differences will be negligible. Therefore, the NUREG/CR-6260 evaluation of the controlling safe end weld is representative for the North Anna SI nozzles.

Conclusion:

Based on the review of the geometry and material for Surry Units 1 & 2 and North Anna Units 1 & 2 Charging nozzles and SI nozzles, it is concluded that the applicable models for the North Anna and Surry nozzle qualification were similar to the NUREG-6260 Turkey Point model in the region of interest. The calculations performed for North Anna and Surry nozzles using the NUREG-6260 methodology have shown that these nozzles are acceptable with consideration of EAF.