VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

March 26, 1992

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

Serial No. 92-184
NL&P/JDH: R5a
Docket No. 50-338
License No. NPF-4

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 1
RESPONSE TO NRC QUESTIONS REGARDING
STEAM GENERATOR PRIMARY-TO-SECONDARY LEAK RATE
CONSIDERED IN MAIN STEAM LINE BREAK ACCIDENT ANALYSIS

On March 2, 1992, a meeting was held between NRC and Virginia Electric and Power Company to discuss the results of the North Anna Unit 1 mid-cycle steam generator inspection. During that meeting, we provided a summary technical evaluation of the inspection results and our basis for restart and operation of the unit until January 1993. At the meeting's end, the NRC granted verbal approval for startup and stated that written approval would be forwarded separately.

Subsequently, during a March 6, 1992 telephone call, the NRC requested that we provide additional information regarding the main steam line break (MSLB) accident for North Anna Unit 1, including a summary comparison of four MSLB accident analyses, the major assumptions and dose consequences for the analyses, the need for a license amendment to impose limits on primary coolant activity, and whether this issue involved a significant hazards consideration.

The four analyses in question are the MSLB analysis currently documented in the UFSAR, a MSLB analysis discussed in our August 6, 1991 submittal which provided an acceptable basis for restart, and two additional MSLB analyses which we conducted at NRC request based on assumptions we believe not to be credible. The first analysis is referred to as the UFSAR analysis. The latter three analyses are referred to by their primary-to-secondary post-accident leak rates of 9.5, 49, and 24.2 gpm. Additional information regarding each analysis, and a summary table illustrating the assumptions and dose consequences are provided in Attachment 1.

It is our position that the 49 and 24.2 gpm analyses and associated dose consequences represent accident scenarios outside the current licensing basis for North Anna Unit 1. Even so, it should be noted that the dose consequences for each of these analyses are well within the criteria required by 10 CFR Part 100. In addition,

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changes in offsite dose consequences resulting from these additional analyses do not constitute a significant safety hazards as defined in 10 CFR 50.92 or require changes to the Technical Specifications. Therefore, the current administrative limits for Technical Specification 3.4.8 on North Anna Unit 1 was voluntarily imposed in December 1991 for additional operational conservatism. The basis for our no significant hazards consideration determination is provided in Attachment 2.

Should you have any questions or require additional information, please contact us.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Attachments

1. Summary Description of MSLB Accident Analyses
2. No Significant Hazards Consideration Determination

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Mr. M. S. Lesser
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ATTACHMENT 1

NORTH ANNA UNIT 1

SUMMARY DESCRIPTION OF MSLB ACCIDENT ANALYSES

VIRGINIA ELECTRIC AND POWER COMPANY

SUMMARY DESCRIPTION OF MSLB ACCIDENT ANALYSES

Introduction

During a March 6, 1992 telephone call, the NRC requested that we provide additional information regarding the main steam line break (MSLB) accident for North Anna Unit 1. In response, the following provides a summary description of the UFSAR MSLB accident analysis, the 9.5 gpm, the 49 gpm, and the 24.2 gpm leak rate assessments, and a detailed methodology for the MSLB dose analysis.

1.0 Analysis Results

Table 2 summarizes the analysis results for the four accident analyses.

1.1 UFSAR MSLB Accident Analysis Summary

A postulated MSLB event is analyzed in Chapter 15, Accident Analyses, of the North Anna Updated Final Safety Analysis Report (UFSAR). The main steam line break event is analyzed as an American Nuclear Society (ANS) Condition IV event due to its anticipated frequency of concurrence and potential radiological consequences to the public. The Chapter 15 analyses consider the offsite dose consequences of the event. Each of the Condition IV faults in the UFSAR are analyzed with respect to the guideline values of 10 CFR Part 100 (i.e., 300 Rem thyroid dose and 25 Rem whole-body dose).

For the main steam line break, the North Anna UFSAR analysis calculated a 3.5 Rem thyroid dose at the site boundary. The UFSAR and the related NRC Safety Evaluation Report for North Anna Power Station Units 1 and 2, NUREG-0053, state that the thyroid dose resulting from a postulated main steam line break is well within the guidelines of 10 CFR Part 100. The UFSAR analysis assumed 1% failed fuel and that a 10 gpm primary-to-secondary leak rate existed for the length of time required to achieve equilibrium activity in the secondary side of the steam generator. This analysis does not include a pre-accident iodine spike as recommended by the NRC Standard Review Plan (SRP) for a main steam line break accident because the analysis was submitted and approved prior to the SRP guidelines.

1.2 9.5 gpm Leak Rate Assessment

North Anna Unit 1 has implemented an administrative leak rate limit of 50 gpd for any steam generator. Therefore, the potential for leakage from a single crack during MSLB is limited by the 50 gpd normal operation leak rate limit. Assuming plant operation at the 50 gpd limit, it is conservative to assume that all the leakage is from a single through-wall axial crack. Evaluating the effect on this single crack due to a MSLB accident results in an upper bound post-MSLB leak rate of 9.5 gpm.

The 9.5 gpm leak rate is less than the 10 gpm leak rate assumed in the UFSAR analysis. Therefore, the radiological consequences at the site boundary are <3.5 Rem when calculated using the licensing basis methodology in the UFSAR. When the pre-accident iodine spike is taken into account, consistent with the SRP, the consequences are 8.18 Rem. Both sets of consequences are well within a small fraction of Part 100 limits.

1.3 <u>49 gpm Leak Rate Assessment</u>

In response to requests from the NRC staff, we determined the post-accident primary-to-secondary leak rate assuming that each of the cracks in an end-of-cycle (EOC) crack distribution would be through-wall and each crack would leak at its maximum potential (reference WCAP-13034). This analysis applies the segmented primary water stress corrosion crack (PWSCC) model for axial and circumferential cracks and assumes the outside diameter stress corrosion cracking (ODSCC) model with 60% of the projected crack angle as through wall. The analysis results indicate the leak rate due to a postulated MSLB would be less than 49 gpm. This evaluation for leakage from an EOC crack distribution is highly conservative in that the projected crack distribution would be expected to leak well in excess of 50 gpd based on application of the leak rate and crack models used in the evaluation (reference WCAP-13034). The 49 gpm calculated leak rate was also based on leakage from the projected crack distribution in three steam generators which is extremely conservative because only one steam generator is affected by the MSLB event.

Although we considered this an overly conservative evaluation, we performed the requested dose calculations assuming a 49 gpm primary-to-secondary leak in the affected steam generator. A discussion of this evaluation was provided to the NRC by letter dated December 5, 1991 (Serial No. 91-693A). We consider this evaluation to be overly conservative because the assumptions ignore both the station administrative limits and the Technical Specification limits for primary-to-secondary leakage for normal operation. In addition, the scenario assumes a pre-accident iodine spike condition of 60.0 μCi/gram dose equivalent Iodine-131, an end-of-cycle (18-month) crack distribution with conservative growth rates, a conservative threshold of detection, and conservative eddy current uncertainty. Further, the scenario assumes each of the cracks in the end-of-cycle distribution is through wall for the majority of its length.

The theoretical offsite dose at the site boundary was calculated to be 37 Rem for the 60.0 μCi/gram case (100% of Technical Specification limit). This dose is larger than what is generally considered a small fraction of the Part 100 limit (10% of 300 Rem, or 30 Rem). Therefore, the primary coolant activity limit was administratively reduced by 25% to ensure that the offsite dose would remain less than a small fraction of Part 100. With the administrative control in place, the resulting theoretical dose consequences were 28 Rem at the site boundary.

1.4 24.2 gpm Leak Rate Assessment

This analysis methodology is the same as the 49 gpm case except that the analysis utilized the actual 1992 Unit 1 mid-cycle inspection results to establish the worst case crack size and number distribution for the most limiting steam generator. The crack size and distribution resulting from this inspection bounds any possible crack distribution for the remainder of the cycle. In brief, it was assumed that all cracks in the as-found distribution are through-wall for their entire projected length (or angle), except for ODSCC circumferential cracks at the tube support plate locations where only 60% of the projected EOC angle was calculated to be through-wall. All cracks in the distribution were assumed to leak, regardless of size. This distribution of cracks was calculated to leak at 24.2 gpm during post-MSLB accident conditions.

Based on this calculated primary-to-secondary leak rate, the theoretical dose consequences at the site boundary were calculated to be 19 Rem, well within a small fraction of the 10 CFR Part 100 limits. This analysis assumed the pre-accident iodine spike condition of 60.0 µCi/gram dose equivalent Iodine-131. Thus, there is no need to administratively lower primary coolant activity as in the 49 gpm case. However, for additional conservatism, the administrative limits are being continued.

2.0 Detailed Methodology for the 24.2 MSLB Dose Analysis

A MSLB involves a postulated complete double ended break in one of the lines leading from a steam generator inside containment to the turbine generator. If this break occurs outside of containment, secondary steam will be released to the environment. The potential doses at the Exclusion Area Boundary (EAB) have been evaluated with the LOCADOSE computer code system described in Reference 1 using the models and assumptions described below.

Radionuclide concentrations in the primary and secondary coolant systems are an important factor in determining the potential doses from a MSLB accident. North Anna Technical Specification 3.4.8 limits the primary coolant specific activity to ≤1.0 µCi/gram dose equivalent Iodine-131 except for short term iodine spikes and Technical Specification 3.7.1.4 limits the specific activity of the secondary coolant system to ≤0.1 µCi/gram dose equivalent Iodine-131. The maximum primary coolant iodine concentration allowed for short term operation at full power is 60 µCi/gram dose equivalent Iodine-131.

2.1 Assumptions

Initial primary coolant radionuclide concentrations were determined by adjusting the radionuclide concentrations for 1% failed fuel shown in Table 11.1-6 of the North Anna UFSAR to the Technical Specifications limit of 1.0 µCi/gram dose equivalent Iodine-

131. The concentrations of the iodine isotopes in the primary coolant were then increased by a factor of 60 to account for the potential for operation with a pre-accident iodine spike of 60 µCi/gram dose equivalent Iodine-131. Note that a pre-accident iodine spike will produce higher potential thyroid doses than an iodine spike that occurs concurrent with a MSLB.

The initial secondary liquid iodine isotope concentrations were set at the Technical Specifications limit of 0.1 µCi/gram dose equivalent Iodine-131 and the initial secondary steam iodine isotope concentrations were determined from the liquid concentrations assuming a partition factor of 100 between liquid and steam.

A primary-to-secondary coolant leak rate of 24.2 gpm into the steam generator affected by the MSLB is assumed. This represents an increase more than a factor of 300 from the maximum North Anna Technical Specifications leak rate of 100 gpd per steam generator. As discussed in the Westinghouse "Tube Integrity Evaluation" presentation to the NRC on March 2, 1992, this is a very conservative leak rate.

2.2 Main Steam Line Break Model

The MSLB was modeled with the LOCADOSE (Reference 1) computer code system. The volumes and masses modeled are provided in Table 1. Releases from the affected steam generator are assumed for thirty minutes until this steam generator is isolated. Releases from the unaffected steam generators through the relief or safety valves are assumed for eight hours after the MSLB. Because the steam released from the affected steam generator exceeds the initial steam generator liquid volume, no credit is taken for iodine partitioning between the liquid and steam. In addition, the release rate from the affected steam generator is increased above that computed by the thermal-hydraulic analysis to minimize any retention of radionuclides in the affected steam generator and to ensure that substantially all of the radionuclides in the affected steam generator are released.

The χ/Q used for the EAB is the same as shown in the North Anna UFSAR (3.1 E-04 sec/m^3). The dose is determined at the EAB for a 2 hour period.

TABLE 1

Volumes and Masses Used in Analysis of Main Steam Line Break

Description	Volume (ft^3)	Mass (lb_m)	Notes
Environment	--	--	
Primary Coolant	9786	437845	
Secondary Liquid	2054	97600	Per Steam Generator
Secondary Steam	3838	7200	Per Steam Generator
Control Room	2.3 E05	--	
Turbine Building	6.0 E06	--	

2.3 Results of LOCADOSE Analysis for Main Steam Line Break

The models and assumptions described above were used to calculate the EAB doses. The MSLB thyroid dose calculated at the EAB based on the models described above is 19 Rem and is less than a small fraction (10%) of the 10 CFR Part 100 limit. The EAB thyroid dose shown in the North Anna UFSAR for a MSLB is 3.5 Rem. This thyroid dose was calculated assuming a primary-to-secondary leak rate of 10 gpm and primary coolant with radionuclide concentrations equivalent to 1% failed fuel. This 10 gpm leak rate was assumed to occur at a time before the MSLB event sufficient to build up secondary side iodine concentrations substantially higher than allowed by Technical Specifications. However, no iodine spiking was assumed in the UFSAR analysis.

Reference

1. "LOCADOSE NE319, A Computer Code System for Multi-Region Radioactive Transport and Dose Calculation," Theoretical Manual, Revision 3, July 1990, Bechtel Power Corporation.

Table 2

North Anna Unit 1
Main Steam Line Break Comparison Table

Pertinent Analysis Assumptions	UFSAR Analysis	Aug. 6, 1991 Submittal	Dec. 5, 1991 Submittal	Mar. 2, 1992 Presentation
Pre-accident Iodine Spike Short-term	No Spike (1% Failed Fuel)	60.0 µCi / gram	45.0 µCi / gram (75% of T.S.)	60.0 µCi / gram
Post-accident Primary-to-Secondary Leak Rate	10 GPM	9.5 GPM	49 GPM	24.2 GPM
Calculated Dose Consequences				
Offsite Dose @ Site Boundary - Thyroid	3.5 Rem	< 3.5 Rem (UFSAR) ----- 8.18 Rem	28 Rem	19 Rem
Offsite Allowable Limits - Thyroid (Part 100)	300 Rem	300 Rem	300 Rem	300 Rem

ATTACHMENT 2

NORTH ANNA UNIT 1

DETERMINATION OF NO SIGNIFICANT HAZARDS CONSIDERATION

VIRGINIA ELECTRIC AND POWER COMPANY

DETERMINATION OF NO SIGNIFICANT HAZARDS CONSIDERATION

Virginia Electric and Power Company has reviewed the MSLB accident scenarios described above and determined that they do not involve a significant hazards consideration as defined in 10 CFR 50.92. The basis for this determination is provided below:

1. Does not involve a significant increase in the probability or consequences of an accident previously evaluated.

   The radiological consequences of the potential 9.5 gpm post-accident primary-to-secondary leakage rate results were evaluated relative to the off-site dose assessment. The leakage rate did not result in any increase in the dose consequences at the site boundary in excess of those previously evaluated and approved by the NRC for North Anna.

   The consequences of the two leak rates outside the licensing basis, 24.2 and 49 gpm, are in excess of those previously reviewed and approved by the NRC. If it was determined that one or the other should be included in the MSLB analysis, it would be our position that an unreviewed safety question exists because the dose consequences would then exceed those previously reviewed and approved by NRC. However, we would also observe that the 24 gpm leak rate results are within the small fraction of Part 100 criterion, and as described previously, the 49 gpm case could be similarly constrained by limiting primary coolant activity. In both cases, the increase in consequences does not exceed the Part 100 limits, nor results in a significant increase over the currently approved dose consequences. Thus, we would conclude that no significant increase in consequences had occurred.

2. Does not create the possibility of a new or different kind of accident from any accident previously evaluated.

   None of the accident analyses described above result in a new or different kind of accident from any accident previously evaluated. The various accident analyses use different assumptions for calculating the post-accident primary-to-secondary leakrates.

3. Does not involve a significant reduction in a margin of safety.

   The increase in dose consequences described above for the 24.2 and 49 gpm cases could be considered as a reduction in a margin of safety. However, in the same manner that we concluded that the increase in dose consequences was not a significant increase, we would also conclude that any corresponding reduction in margin was not a significant reduction.

Based on the above significant hazards consideration evaluation, Virginia Electric and Power Company concludes that the effect of any changes to the MSLB accident analysis do not constitute a significant hazards consideration as described in 10 CFR 50.92.