VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

November 15, 2000

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

Serial No.	00-556
NL&OS/ETS	R0
Docket Nos.	50-338
	50-339
License Nos.	NPF-4
	NPF-7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
PROPOSED TECHNICAL SPECIFICATION CHANGES
INCREASED BORON CONCENTRATION
REQUEST FOR ADDITIONAL INFORMATION

In a June 22, 2000 letter (Serial No. 00-305), Virginia Electric and Power Company requested amendments, in the form of changes to the Technical Specifications to Facility Operating Licenses Numbers NPF-4 and NPF-7 for North Anna Power Station Units 1 and 2, respectively. The proposed changes will increase the boron concentration limits in the refueling water storage tank, casing cooling tank, safety injection accumulators and the spent fuel pool. In a letter dated October 23, 2000, the NRC requested additional information regarding the method used for determining the amount of sodium hydroxide to be added to the chemical addition tank to maintain post-Loss of Coolant Accident (LOCA) sump pH to compensate for the proposed increases in boron concentration. The attachment to this letter provides a description of the method used to calculate the minimum and maximum post-LOCA sump pH.

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

Very truly yours,

Leslie N. Hartz
Vice President - Nuclear Engineering and Services

Attachment

Commitments made in this letter: None

A001

cc: U.S. Nuclear Regulatory Commission
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COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by Leslie N. Hartz, who is Vice President - Nuclear Engineering & Services, of Virginia Electric and Power Company. She has affirmed before me that she is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged before me this 15th day of November, 2000.

My Commission Expires: March 31, 2004.

Maggie McClure

Notary Public

(SEAL)

Attachment 1

Request for Additional Information (RAI) Related to the Proposed Technical Specification Changes to Increase Boron Concentration

North Anna Power Station
Units 1 and 2
Virginia Electric and Power Company

Response to NRC RAI Regarding the Increased Boron Concentration Technical Specification Change Request

Introduction

A Technical Specification (TS) Change Request (TAC NOS. MA9362 and MA9363) was submitted to the NRC for review by letter dated June 22, 2000. The submittal included evaluations of increased boron concentrations in the refueling water storage tank (RWST), casing cooling tank (CCT), Safety Injection Accumulators (SIAs), and the spent fuel pool (SFP).

The post-LOCA sump pH was reanalyzed as a result of the increased boron concentration. During an October 4, 2000 teleconference, the NRC requested additional information concerning the amount of sodium hydroxide that would need to be added to the chemical addition tank (CAT) to compensate for the proposed increases in boron concentration. The NRC requested a written response to their inquiry, and issued a Request for Additional Information (RAI) on October 23, 2000. The NRC RAI specifically states,

The TS change proposes to increase the boron concentration in the refueling water storage tank (RWST), casing cooling tank, and safety injection accumulators, which will result in lower pH values. The required pH ranges are 7 to 9.5 and 8.5 to 10.5 for the quench spray and containment sump respectively. As such, the amount of sodium hydroxide from the chemical addition tank into the quench spray pump suction, downstream of the RWST, will have to be increased. Describe in detail your method for determining the amount of sodium hydroxide to be added to compensate for the proposed increases in boron concentration.

Our response to the RAI is provided below.

Analysis Description

Following a Small or Large Break Loss of Coolant Accident (SBLOCA or LBLOCA), fluid from volumes containing boric acid solution or sodium hydroxide solution accumulate in the containment sump. At North Anna, these volumes include the Refueling Water Storage Tank (RWST), the Chemical Addition Tank (CAT), the Boron Injection Tank (BIT), the Casing Cooling Tank (CCT), the Safety Injection Accumulators (SIAs), the Reactor Coolant System (RCS), the Safety Injection System Piping (SI Piping), and the Safety Injection Accumulator Piping (SIA Piping). All of these volumes contain boric acid solution with the exception of the CAT, which contains sodium hydroxide solution. Lithium Hydroxide is utilized in the RCS to maintain pH at approximately 7.0. Depending on the magnitude of the loss of coolant accident (LOCA), some or all of the liquid contained in these volumes will be introduced to containment, and will ultimately accumulate in the containment sump. The resulting pH in the containment sump, and therefore in the recirculation spray (RS), is dependent on the magnitude of the LOCA. In the existing analysis of record, which applies to the design basis LBLOCA, all of the liquid in these volumes (except unusable volumes) is assumed to be transferred to containment. It is

conservative to assume that the entire volume RCS and SI piping is transferred to the containment sump, even though some of this liquid would be held up.

Method of Analysis

The following outline describes the method employed in the calculation for determining the maximum and minimum sump pH:

1) **SUMP pH CALCULATION:** The pH of the post-LOCA sump for the design basis large break LOCA is determined by a volume-weighted average of the boric acid and sodium hydroxide concentrations from each analyzed volume. Because the pH tabular data assumes that boric acid and sodium hydroxide concentrations are expressed as molarities (moles solute per liter), each volume's concentration (weight percent) is converted to a molarity prior to "mixing" the contents of the individual volumes in the sump. The tabular data tables are presented as Tables V and VI.

2) **DENSITY CORRECTION FOR SUMP pH CALCULATION:** Because there can be substantial differences between the thermal hydraulic conditions in the post-LOCA sump and the conditions in the individual volumes (i.e., RWST, CAT, BIT, RCS, CCT, SI piping, and SIAs), density corrections are included in the sump pH calculations. Prior to "mixing", each volume is scaled by a ratio of the post-LOCA sump density to the "pre-mixed" volume density. Each volume is assumed to be at its "best estimate" or "average" pressure. However, temperature is assumed to vary uniformly between the high and low control limits.

3) **RANGE OF PARAMETERS CONSIDERED:** The *actual* usable tank volumes and solute concentrations are assumed to vary within the range defined by each tank's minimum and maximum surveillance limits. Volumes considered in this analysis include the RWST, CAT, BIT, CCT, SIAs, containment sump, RCS, SI piping, and SIA piping. The input parameters are presented in detail in Tables I through IV. These table values are adjusted for uncertainties as described in 5) below.

4) **MODELING OF VOLUME AND SOLUTE CONCENTRATION VARIATION:** The actual volume or solute concentration is assumed to vary in accordance with a uniform distribution between the *minimum volume (or solute concentration)* and the *maximum volume (or solute concentration)* defined by surveillance limits. Actual tank volumes (or solute concentrations) tend to be maintained at values well away from established limits to minimize the probability of violating the limit during surveillance. Inherent in the uniform distribution is the conservative assumption that a tank volume (or solute concentration) has equal probability of being at any value between the two extremes of the range. These table values are adjusted for uncertainties as described in 5) below.

5) **MODELING OF VOLUME AND SOLUTE CONCENTRATION UNCERTAINTY:** Variation due to key parameter measurement uncertainties (i.e., uncertainties in

tank volume and solute concentration) and variation of key parameters within their respective surveillance bands are modeled independently. Key parameter measurement uncertainties are modeled as normally distributed.

6) **MODELING OF THE pH OF THE RCS COOLANT**: During normal operation, the RCS coolant pH is controlled by varying the concentration of lithium hydroxide (LiOH). For the purposes of this calculation, the presence of lithium hydroxide was simulated by adjusting an equivalent concentration of sodium hydroxide in the RCS coolant. This approach was taken due to the complexity of modeling a solution of H_3BO_3, NaOH, and LiOH. The pH of the RCS is assumed to vary as a binomial distribution with a 50% probability of being at either extreme of the control band.

7) **QUENCH SPRAY "HOLD UP":** A fraction of quench spray flow is assumed to be "held up" in the reactor cavity and not transferred to the containment sump. This volume is calculated as the ratio of the reactor cavity area to the total area covered by quench spray. Quench spray outside the area of the reactor cavity has adequate drain paths to ensure mixing with other volumes in the containment sump. The fraction of quench spray which is assumed to be held up is 8%.

8) **MONTE CARLO APPROACH:** The analysis calculates the sump pH for ten thousand randomly selected volumes, solute concentrations, and tank temperatures, in accordance with the distributions described above. The minimum pH value is selected at the point at which the integrated number of observations at the lower "tail" of the distribution is 2.5% and the maximum pH value is selected at the point at which the integrated number of observations a the upper "tail" of the distribution is 97.5%. Therefore, sump pH is concluded to lie between the minimum and maximum values with 95% probability and confidence.

Analysis Data

The calculation of pH in the containment sump following a LOCA is influenced primarily by two factors: the available water volumes and solute concentrations (boric or sodium hydroxide) which discharge to the sump. Tables I through IV provide the key design input parameter values that are used in calculating the minimum and maximum sump pH.

Table I. Tank Volumes

Tank	Maximum Volume (gallons)	Minimum Volume (gallons)	Allowance for Measurement Uncertainty (gallons)
RWST	483470	449416	16612
CAT	5500	4684	315
BIT	990	900	0
CCT	119082	106414	6611
SIA	22162	21634	107
Sump*	5000	0	0
RCS	69494	69494	1878
SI Piping	241	241	0
SIA Piping	1106	1106	0

* Volume of water that may be expected to be in the sump during normal operation.

Table II. Boron Concentrations

Tank	Maximum Concentration (ppm)	Minimum Concentration (ppm)	Allowance for Measurement Uncertainty (ppm)
RWST	2800	2600	28
CAT	0	0	0
BIT	15750	12950	157.5
CCT	2800	2600	28
SIA	2800	2500	28
Sump	0	0	0
RCS	**	**	0
SI Piping	***	***	0
SIA Piping	***	***	0

** The concentration of NaOH and H_3BO_3 is set to achieve an RCS pH of either 6.9 or 7.4.

*** The concentration of NaOH and H_3BO_3 is set to equal that of the RCS.

Table III. Sodium Hydroxide Concentrations

Tank	Maximum Concentration (ppm)	Minimum Concentration (ppm)	Allowance for Measurement Uncertainty (ppm)
RWST	0	0	0
CAT	130000	120000	1300
BIT	0	0	0
CCT	0	0	0
SIA	0	0	0
Sump	0	0	0
RCS	**	**	0
SI Piping	***	***	0
SIA Piping	***	***	0

** The concentration of NaOH and H_3BO_3 is set to achieve an RCS pH of either 6.9 or 7.4.
*** The concentration of NaOH and H_3BO_3 is set to equal that of the RCS.

Table IV. Tank Temperatures and Average Pressures

Tank	Minimum Tank Temperature (°F)	Maximum Tank Temperature (°F)	Average Tank Pressure (psia)
RWST	40	50	14.7
CAT	35	100	14.7
BIT	115	140	14.7
CCT	35	50	14.7
SIA	86	100	613.7
Sump	70	70	14.7
RCS	580.8	580.8	2250
SI Piping	35	120	2250
SIA Piping	35	120	2250

Table V. pH Lookup Data – Boric Acid Versus Sodium Hydroxide Molarity

	Boric Acid (M)						
NaOH (M)	0.00	0.05	0.10	0.20	0.30	0.40	0.50
0.00	7.00	5.40	5.10	4.80	4.50	4.30	4.20
0.01	10.00	6.65	6.20	5.85	5.55	5.20	5.00
0.02	11.00	7.70	7.20	6.80	6.45	5.90	5.75
0.03	11.65	8.60	7.95	7.45	7.05	6.50	6.35
0.04	12.00	9.40	8.60	7.95	7.50	7.10	6.90
0.05	12.25	10.15	9.10	8.30	7.90	7.50	7.20
0.06	12.40	10.80	9.45	8.50	8.10	7.75	7.45
0.07	12.50	11.30	9.85	8.75	8.35	7.95	7.55
0.08	12.55	11.70	10.10	8.90	8.45	8.10	7.65
0.09	12.58	12.05	10.30	9.05	8.55	8.20	7.80
0.10	12.60	12.25	10.60	9.15	8.60	8.25	7.90
0.13	12.75	12.50	11.20	9.60	8.90	8.50	8.20
0.17	12.80	12.60	12.20	10.40	9.20	8.85	8.50
0.21	12.80	12.65	12.55	11.20	9.70	9.20	8.90
0.25	12.90	12.80	12.70	12.00	10.35	9.50	9.15

Table VI. Boric Acid Molarity Versus pH

	Boric Acid (M)						
pH	0.00	0.05	0.10	0.20	0.30	0.40	0.50
5.00				0.00	0.00	0.01	0.01
5.50		0.00	0.00	0.01	0.01	0.01	0.02
6.00		0.00	0.01	0.01	0.02	0.02	0.02
6.50		0.01	0.01	0.02	0.02	0.03	0.03
7.00	0.000	0.013	0.018	0.023	0.029	0.038	0.043
7.50	0.002	0.018	0.024	0.031	0.040	0.050	0.065
8.00	0.003	0.023	0.031	0.040	0.055	0.073	0.110
8.50	0.005	0.029	0.038	0.060	0.085	0.130	0.226
9.00	0.007	0.035	0.048	0.087	0.143	0.187	
9.50	0.008	0.041	0.061	0.123	0.194	0.250	
10.00	0.010	0.048	0.076	0.150	0.228		
10.50	0.015	0.055	0.097	0.175			
11.00	0.020	0.064	0.120	0.200			
11.50	0.028	0.075	0.142	0.225			
12.00	0.040	0.089	0.162	0.250			
12.50	0.070	0.130	0.204				

Analysis Results

The post-LOCA sump pH results for an increased RWST, CCT, and SIA boron concentration are presented below.

Table VII. Analysis Results

Current Design	2 ½ % probability lower bound	7.31
	2 ½ % probability upper bound	7.70
Proposed Design	2 ½ % probability lower bound	7.18
	2 ½ % probability upper bound	7.58

Although the lower bound pH values decreased as a result of increased boron concentrations in the RWST, CCT, and SIAs, the post-LOCA sump pH analysis limits (i.e., post-LOCA sump pH greater than 7.0 and less than 9.5) continue to be met without increasing the sodium hydroxide concentration in the CAT.