VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

December 21, 1990

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Serial No.	90-746
NL/RPC	R2
Docket Nos.	50-280
	50-281
License Nos.	DPR-32
	DPR-37

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
PROPOSED TECHNICAL SPECIFICATION CHANGE
BORON CONCENTRATION INCREASE

Pursuant to 10 CFR 50.90, Virginia Electric and Power Company requests an amendment, in the form of changes to the Technical Specifications, to Operating License Nos. DPR-32 and DPR-37 for Surry Power Station Units 1 and 2.

The proposed Technical Specification change will increase boron concentration in the Refueling Water Storage Tank (RWST) to a range of 2300 - 2500 ppm from the current range of 2000 - 2200 ppm. In addition, the minimum boron concentration in the safety injection accumulators would be increased to 2250 ppm from the present value of 1950 ppm. These limits apply to Cycle 12 and subsequent cycles for Unit 1 and to Cycle 11 and subsequent cycles for Unit 2. The proposed change is required in order to meet the increased cycle energy requirements associated with longer cycles and higher load factors. The provisions of the proposed change must be in place prior to reloading of fuel for Unit 2.

Attachment 1 provides a discussion of the proposed changes as well as the interaction of this submittal with two previously issued amendments and a proposed Technical Specification change request currently under review by the NRC. The Technical Specification pages affected by this proposed change are included in Attachment 2.

The proposed change has been reviewed and approved by the Station Nuclear Safety and Operating Committee. It has been determined that this change does not involve an unreviewed safety question as defined in 10 CFR 50.59 and, as shown in Attachment 3, involves no significant hazards considerations according to 10 CFR 50.92.

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In order to support reload core design and safety analysis for the upcoming Unit 2 refueling, we request NRC approval of this proposed change by April 1, 1991.

Very truly yours,

RJ Saunders

for W. L. Stewart
Senior Vice President - Nuclear

Attachments
1. Discussion of Proposed Technical Specification Changes
2. Proposed Technical Specification Pages
3. Discussion and Significant Hazards Consideration Evaluation

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 R. F. Saunders, who is Assistant Vice President - Nuclear Operations, for W. L. Stewart who is Senior Vice President - Nuclear, of Virginia Electric and Power Company. He is duly authorized to execute and file the foregoing document in behalf of that Company, and the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 21st day of December, 1990.

My Commission Expires: May 31, 1994.

Vicki L. Hull
Notary Public

(SEAL)

ATTACHMENT 1

DISCUSSION OF
PROPOSED TECHNICAL
SPECIFICATION CHANGES

INTRODUCTION

The fuel cycles currently being designed for Surry Units 1 and 2 require higher boron concentrations than previous cycles in order to meet shutdown requirements associated with increased cycle length and higher load factors. A safety evaluation has been performed which justifies increasing the boron concentration in the refueling water storage tank (RWST) from the current Technical Specification limits of 2000-2200 ppm to 2300-2500 ppm. Additionally, a safety injection accumulator minimum boron concentration increase to 2250 ppm is proposed.

The following section describes the proposed Technical Specifications changes in detail. A discussion of the analyses and evaluations performed in support of these changes is then presented.

PROPOSED TECHNICAL SPECIFICATION CHANGES

Several Technical Specifications need to be changed to incorporate increased boron concentration limits. Proposed changes to the Unit 1 and 2 Technical Specifications include:

1.	T.S. 3.2.F	Chemical and Volume Control System
2.	T.S. 3.2 (Basis)	Chemical and Volume Control System
3.	T.S. 3.3.A	Safety Injection System
4.	T.S. 3.4.A	Spray Systems
5.	T.S. 3.4 (Basis)	Administrative Correction
6.	T.S. 3.8 (Basis)	Administrative Correction
7.	T.S. 3.10.A	Refueling
8.	T.S. 3.10 (Basis)	Refueling
9.	T.S. 5.4.C	Fuel Storage

These changes are discussed in greater detail in the following sections.

•Addition of Technical Specification 3.2.F and Associated Basis Specification of Primary Grade Water Flow Path Lockout Requirement

The requirement for lockout of the primary grade water flow path during refueling and cold shutdown conditions is specified in T.S. 3.2.F and 3.2 (Basis). This requirement is most appropriately placed here, as this section delineates the requirements for the Chemical and Volume Control System (CVCS), of which the primary grade flow path is a part.

Lockout of the primary grade water flow path during refueling and cold shutdown conditions makes an unplanned boron dilution at these conditions highly improbable, since the source of primary grade water is isolated. At intermediate shutdown and hot shutdown, an administrative shutdown margin requirement ensures that there is adequate time for corrective operator action in response to an inadvertent boron dilution. It has been determined that the current Technical Specification requirement for shutdown margin provides adequate time for corrective operator action in response to an unplanned boron dilution at reactor critical and at power conditions.

Technical Specification 3.2.A states that "the minimum capability for boric acid injection shall be equivalent to that supplied from the refueling water storage tank." Although the RWST boron concentration is being increased, no change to T.S. 3.2.A is proposed for the following reason. The basis for T.S. 3.2.A states that "the quantity of boric acid in storage from either the boric acid tanks or the refueling water storage tank is sufficient to borate the reactor coolant in order to reach cold shutdown at any time during core life." The equivalency indicated in T.S. 3.2.A refers to an equivalent capability of either the boric acid storage tank (BAST) or the RWST to borate the reactor coolant to bring the reactor to cold shutdown. Although the BAST does not have an equivalent quantity of boric acid to that of the RWST, either tank has sufficient capability to bring the unit to a cold shutdown condition. This will remain true for cores designed under the conditions of the proposed increased refueling boron concentration. For this reason, no amendment to T.S. 3.2.A is proposed.

- Change to Technical Specification 3.3.A, 3.4.A, 3.10.A, and 3.10 (Basis); Revision of RWST Boron Concentration Limits

The RWST boron concentration limits are changed from 2000-2200 ppm to 2300-2500 ppm in T.S. 3.3.A and 3.4.A. In T.S. 3.10.A and 3.10 (Basis), the limit values are changed from 2000 to 2300 ppm. Similarly, the minimum boron concentration limit for the accumulators is changed from 1950 ppm to 2250 ppm in T.S. 3.3.A. Raising the boron concentration limits provides additional negative reactivity to compensate for increased reactivity associated with longer cycles and higher load factors.

•Change to Technical Specifications 3.4 (Basis) and 3.8 (Basis); Administrative Corrections

Two Technical Specification changes which are adminstrative in nature are proposed to correct past oversights. The first corrects a sentence in T.S. 3.4 (Basis) which indicates that the refueling water storage tank contains water which is borated to a concentration which ensures reactor shutdown by approximately 10% ΔK/K when all control rod assemblies are inserted and when the reactor is cooled down for refueling. License Amendment No. 106, which was issued on April 22, 1986 (1), changed this ensured shutdown margin to 5% ΔK/K. Technical Specification 3.8 (Basis) currently indicates that the allowable value for the containment air partial pressure is presented in T.S. Figure 3.8-1 for service water temperatures from 25 to 90 F. In fact, the range of service water temperatures covered by this figure are from 25 to 92 F. This change is documented in License Amendment No. 71 dated June 23, 1981 (2).

Also, in our letter (Serial No. 89-800) dated December 22, 1989, a separate change request concerning Technical Specification 3.4.A.6 on page T.S. 3.4-2 was submitted to the NRC. Due to the lower priority given to this previously submitted request, the proposed page T.S. 3.4-2 included in the boron concentration increase change request (Attachment 2) does not indicate the previously submitted request.

•Change to Technical Specification 5.4.C Revision to Spent Fuel Boron Concentration

It is proposed that T.S. 5.4.C be revised to require that the minimum boron concentration in the spent fuel pool be 2300 ppm. Such action will prevent an inadvertent boron dilution when spent fuel pool water comes in contact and mixes with reactor coolant system (RCS) water during transfer of spent fuel. An acceptable region for storage of spent fuel is defined as a function of burnup and initial fuel enrichment in T.S. Figure 5.4-1. Although Figure 5.4-1 remains applicable for an increased refueling boron concentration, the text of T.S. 5.4.C must be changed to indicate a 2300 ppm minimum permissible boron concentration.

DISCUSSION AND EVALUATION

Each of the Chapter 14 transients from the UFSAR was evaluated. In addition, the time to switchover between cold and hot leg recirculation for long-term cooling following a loss of coolant accident (LOCA) was analyzed to determine the impact of the increased boron concentration. The post-LOCA containment sump pH was calculated with the increased boron concentration to ensure that the pH stays within acceptable limits. Finally, the boron concentration used to qualify the electrical equipment in containment subject to containment spray was reviewed to make sure that a higher boron concentration does not violate the qualification envelope of any equipment. The results of these evaluations are presented below.

NON-LOCA UFSAR TRANSIENTS

Of the non-LOCA transients, only the boron dilution was found to have potentially more severe results because of the increased boron concentration. The other non-LOCA transients either were not impacted or were made less severe as a result of the increased boron concentration. Only the boron dilution transient was reanalyzed due to the postulated negative impact of the boron concentration increase.

(A) BORON DILUTION AT REFUELING AND COLD SHUTDOWN CONDITIONS

The boron dilution transient was considered for refueling, cold shutdown, intermediate shutdown, hot shutdown, reactor critical, and at-power conditions. It is necessary to show that adequate time for corrective operator action exists between the time of an alarm indicating a dilution in progress to the loss of shutdown margin. As an alternative for refueling and cold shutdown conditions, it is proposed that the primary grade water source be locked out. Isolation of the primary grade water flow path at these conditions effectively precludes the possibility of an inadvertent boron dilution accident. Following a planned dilution at these conditions, the primary grade water flow path shall be locked out within 15 minutes. This requirement makes an unplanned dilution following a planned dilution highly unlikely. It is proposed that this requirement be added in the form of a new Technical Specification Section, 3.2.F. A similar requirement exists in the North Anna Technical Specifications.

(B) BORON DILUTION AT INTERMEDIATE SHUTDOWN AND HOT SHUTDOWN

Minimum available response time for corrective operator action during intermediate shutdown and hot shutdown is currently ensured through an administratively implemented shutdown margin requirement. The currently applicable boron dilution analysis measures available operator response time from initiation of moderator dilution rather than from the first positive indication of a dilution in progress. The shutdown margin requirement ensures that a minimum of 15 minutes are available from initiation of dilution to criticality at these operating conditions. The NRC was advised of the actions taken to preclude dilution incidents at Surry Power Station in Reference (7). The actions were approved in Reference (8).

For intermediate shutdown and hot shutdown under the proposed Technical Specifications, an administratively implemented shutdown margin requirement has been established which will ensure that there are at least 15 minutes available from initiation of dilution to loss of shutdown margin for corrective operator action. This administrative requirement ensures that the probability of an inadvertent criticality due to a boron dilution event is low.

There are several other factors which contribute to the safe operation of the plants at intermediate shutdown and hot shutdown under the proposed Technical Specifications:

1. During intermediate and hot shutdown conditions, the source range nuclear instrumentation is operable providing an alarm to indicate an uncontrolled dilution in progress.

2. In accordance with Station Operating Procedures, the shutdown rod banks shall be withdrawn from the core while the unit is in startup conditions through power operation conditions. Should an unplanned boron dilution incident occur with the reactor at these conditions (either because of equipment failure or operator error), the high flux at shutdown alarm will alert the operator of this condition and the shutdown rod banks can be inserted into the core immediately. This will give the operator sufficient time to isolate the sources of primary grade water from the reactor coolant system before shutdown margin is lost.

3. An additional indication of the status of the primary grade water system is provided by the primary grade water flow rate recorder on the vertical board in the main control room.

(C) BORON DILUTION AT REACTOR CRITICAL AND AT POWER

The analysis of the boron dilution event at reactor critical conditions indicates that at least 15 minutes are available from positive indication of a dilution in progress (alarm or reactor trip) to loss of shutdown margin for corrective operator action. The analysis conservatively assumes a minimum of 1.77% shutdown margin at the beginning of the dilution.

The boron dilution at power event was analyzed for the rods in automatic and manual control cases. The rods in automatic control case was shown to be bounded by the rods in manual control case. To illustrate, if an initial boron concentration, a dilution flow rate, and a boron worth are assumed, the rods in manual case will result in a reduction of shutdown margin potentially beyond that of the minimum shutdown margin required by Technical Specifications. If rods are in automatic, an alarm will indicate that a dilution is in progress before the rod bank reaches the rod insertion limit, the point at which minimum shutdown margin is defined. Therefore, the rods in manual case is assumed to consume a portion of minimum shutdown margin resulting in an operator response time which is always less than that of the corresponding rods in automatic control case. The automatic control case is therefore bounded by the manual control case.

The reactivity insertion transient resulting from an inadvertent boron dilution is essentially identical to that of a control rod assembly withdrawal accident. The reactivity insertion rates used in the analysis are well within the range of reactivity insertion rates considered in UFSAR Section 14.2.2, "Uncontrolled Control-Rod Withdrawal at Power." If the reactor is in manual control and the operator takes no action to correct an inadvertent boron dilution, the power and temperature will rise to the overtemperature delta-T trip setpoint. Before the overtemperature delta-T trip, an overtemperature delta-T alarm and turbine runback would be actuated. The time to trip varies with the reactivity insertion rate (which is a function of boron concentration and boron worth) and with the temperature and power reactivity feedback of the core (which are largely functions of burnup). It has been shown that 15 minutes are available after a reactor trip before the reactor can return to critical, conservatively assuming a minimum of 1.77% shutdown margin at the beginning of the dilution.

The results of the reactor critical, and both the automatic manual control cases of the boron dilution at power analyses indicate that at least 15 minutes are available from positive indication of a dilution in progress (alarm or reactor trip) to loss of shutdown margin. This is ample time for corrective operator action in response to an unplanned boron dilution. No primary grade water lockout is required at reactor critical or at power conditions.

LOCA EVALUATION

The effect of an increased boron concentration on the LOCA transient was considered for both the large and small break scenarios. The large break LOCA is characterized by a rapid depressurization which causes the generation of significant voiding in the RCS. In accordance with Appendix K, the docketed Surry LBLOCA analysis (3) does not assume control rod insertion. As a result, heat generation in the core is reduced to decay heat levels by void reactivity. Therefore during the blowdown phase of the LBLOCA, the core is shutdown and remains shutdown due to void reactivity.

The Refill/Reflood portion of the injection phase begins with the highly voided core and continues from downcomer refill through core reflood. During this time void reactivity is of primary importance at the start and gradually begins to be replaced by boron as the primary source of negative reactivity. The docketed Surry LBLOCA analysis shows that the peak clad temperature is reached during this phase of the LBLOCA. Because the effect of boron is not modeled in the Refill/Reflood phase of a LBLOCA, the increased boron concentration has no effect on the calculated results for the LBLOCA.

The recirculation phase of the LBLOCA is characterized by the recirculation of water from the containment sump to the safety injection point of the cold leg and into the vessel where it removes heat being generated due to fission product decay. The water flows through the core and out the break as a steam-water mixture. The containment sump water comes from the various NSSS/BOP components which discharge during the injection phase of the LBLOCA. Thus, the containment sump boron concentration is a volume-weighted average of the concentration in the safety injection accumulators, the refueling water storage tank (RWST), the chemical addition tank (CAT), and the reactor coolant system (RCS). The boron concentration of this water is determined during the design process and verified during the reload safety evaluation process to be sufficient to maintain the core subcritical with all rods out at cold zero power. In this manner General Design Criterion (GDC) 26 is met and subcriticality is maintained. Thus, the increased boron concentration does not impact the design constraint to maintain subcriticality at cold zero power with all rods out, so the recirculation phase of the transient is unaffected by the higher boron concentration.

The small break LOCA (SBLOCA) analysis falls into the category of those transients which cause safety injection actuation. The control rods are assumed to insert and cause a trip. Safety injection is actuated at the appropriate pressure and would provide increased shutdown capability with a higher boron concentration. As above, the core is designed to maintain subcriticality at cold zero power even without the control rods inserted, and the presence of the increased boron in no way alters this design limit.

RECIRCULATION SWITCHOVER TIME

Following a LOCA, borated water is injected into the vessel from the RWST and accumulators during the injection phase of the transient. As the RWST empties, switchover to the recirculation phase occurs automatically based on a level setpoint. In the recirculation phase, borated water is pumped from the containment sump into the reactor vessel to remove decay heat. Pool boiling heat transfer takes place in the vessel producing steam which condenses in the containment. The boron concentration in the core gradually increases because the boron does not vaporize along with the water. The flow path of the recirculation water must be alternated between hot leg and cold leg injection periodically to sweep the core of the higher boron concentration water. Because of the proposed boron concentration increase, the recirculation switchover must occur sooner to avoid boron precipitation in the vessel. The currently accepted boron precipitation limit is 23.5 weight percent which includes a four weight percent margin for uncertainties (4).

A new hot leg recirculation switchover time was calculated for an increased RWST and accumulator boron concentration. The analysis assumed a simple, conservative two volume (i.e. containment and reactor vessel) model. The switchover interval remains constant over time even though the decay heat (and therefore pool boiling) diminishes as a function of time. Upon approval of the proposed Technical Specifications, the new switchover time will be implemented into the Surry emergency procedures.

CONTAINMENT AND RECIRCULATION SPRAY pH

Limits are placed on the containment spray pH because of material considerations and to reduce the evolution of iodine from the liquid. A pH range from 7.0 to 9.5 is specified in the Standard Review Plan (SRP)

Section 6.1.1 primarily to avoid conditions which enhance stress corrosion cracking (5). A pH range from 8.5 to 10.5 is specified in SRP Section 6.5.2 (5) to minimize the evolution of iodine during post-LOCA operation of the containment spray system.

The containment spray system pH is determined by calculating the solute and solution flow rate from the RWST and the Chemical Addition Tank (CAT). The ratio of the concentrations of H_3BO_3 and NaOH in the combined solution is used to determine the containment spray pH. The minimum and and maximum containment spray pH were determined to be 8.9 and 10.4, respectively. These values are well within the range specified by the SRP for minimization of the evolution of volatile iodine species. However, the maximum calculated containment spray pH value is 0.9 units beyond the maximum value recommended by the SRP for avoidance of conditions which enhance stress corrosion cracking. Because the injection mode lasts only a short time before spray is transferred over to the recirculation mode, the maximum value of containment spray pH which was calculated is not a safety concern.

Before the RWST empties the containment spray subsystem is removed from service and the recirculation spray subsystem provides the containment cooling function. The recirculation spray pumps take suction from the containment sump. The sump pH is calculated by considering the boric acid and sodium hydroxide concentrations in the RCS, the SIA's, the RWST and the CAT. The minimum and maximum ultimate sump pH values were determined to be 7.9 and 8.5, respectively. These values are well within the range of values specified by the SRP for stress corrosion cracking concerns.

However, the minimum pH value is not within the range of values specified by the SRP for iodine removal considerations. It may be concluded, however, that iodine evolution is not a concern for the recirculation phase of a LBLOCA because the Surry containment is sub-atmospheric within one hour of the design basis accident by design.

OTHER EVALUATIONS

Other design constraints were also evaluated and shown to be met. Boron precipitation in the RWST/Accumulator was considered and found not to occur below concentrations of about 2.5 weight percent (~4370 ppm) at temperatures above 32^{o}F (6). Increasing the boron concentration limit from 2000-2200 ppm to 2300-2500 ppm was shown to not adversely affect the environmental qualification of electrical equipment. The corrosive agent in the chemical spray is primarily NaOH. Increasing the boron concentration lowers the solution pH, making it less corrosive (closer to neutral). Therefore, the higher boron concentration limits were shown to be acceptable, even for those components qualified at a lower boron concentration.

IMPLEMENTATION

Because Surry Units 1 and 2 are not projected to be in simultaneous outages following the approval of the proposed Technical Specification changes, it is proposed that the changes be implemented first for Surry Unit 2 during its Cycle 10/11 refueling outage, and then for Unit 1 during its Cycle 11/12 outage. A footnote has been added to the proposed Technical Specification changes to indicate proposed implementation times.

The reload core design and safety analyses for Surry 2 Cycle 11 will presume the increased refueling boron concentration range. Thus prior to the onload of the Surry 2 Cycle 11 reload core, the boron concentration in the Surry 2 RWST, the Spent Fuel Pool, and the Surry 2 Safety Injection Accumulators will be increased to within the range specified in the proposed Technical Specifications. Similarly the Surry 1 RWST, the Surry 1 Safety Injection Accumulators, and the RWST cross-ties will be increased to within the specified range prior to the onload of the Surry 1 Cycle 12 fresh fuel region.

Since increasing the RWST concentrations is a lengthy process, a provision to permit it to be accomplished prior to shutdown has been added to the footnotes of the proposed Technical Specifications changes.

The Spent Fuel Pool, Safety Injection Accumulators, and RWST boron concentrations will be increased in a manner prescribed by approved station procedures. All accident analysis criteria will continue to be met during the transition to the increased refueling and safety injection accumulator boron concentration ranges.

CONCLUSIONS

In support of an increased refueling boron concentration, each of the Chapter 14 transients from the UFSAR was evaluated. Only the boron dilution accidents required reanalysis. To prevent an inadvertent boron dilution at refueling and cold shutdown conditions, lockout of the primary grade water flow path within 15 minutes following a planned dilution or makeup to the RCS is proposed. For the boron dilution event at intermediate shutdown and hot shutdown, administratively controlled shutdown margin limits ensure that at least 15 minutes are available from initiation of dilution to loss of shutdown margin for corrective operator action. The boron dilution at reactor critical and at power analysis showed that at least 15 minutes are available for corrective operator action from positive indication of a dilution in progress (alarm or reactor trip) to loss of shutdown margin. The time to switchover between cold and hot leg recirculation following a LOCA was analyzed to determine the impact of the larger boron concentration. The post-LOCA containment sump pH was also calculated with the larger boron concentration to ensure that the pH stays within acceptable limits. The boron concentration used to qualify the equipment in containment subject to chemical spray was reviewed to make sure that a higher boron concentration does not exceed the qualification envelope of such equipment. Finally, measurement and calculational uncertainties were considered. In summary, each pertinent safety criterion was evaluated for an increased boron concentration and all were found to be acceptable.

REFERENCES

1. Surry Technical Specification Amendment No. 106, NRC Letter Serial No. 86-277.

2. Surry Technical Specification Amendment No. 71, NRC Letter Serial No. 81-395.

3. Letter from W. L. Stewart (Virginia Electric and Power Company) to USNRC, "Virginia Electric and Power Company Amendment to Operating Licenses DPR-32 and DPR-37, Surry Power Station Units 1 and 2, Increased FQ(Z) and Accumulator Volume Operating Band," Serial No. 87-001, dated February 23, 1987.

4. Letter from W. L. Stewart to USNRC, "Virginia Electric and Power Company, North Anna Power Station Units No. 1 and 2, Proposed Technical Specification Change, Boron Concentration Increase," Serial No. 86-690, dated December 22, 1986.

5. USNRC Standard Review Plan, NUREG 0800.

6. North Anna Power Station Updated Final Safety Analysis Report, Revision 4, Figure 6.3.21, June, 1986.

7. Letter from B. R. Sylvia (Vepco) to J. P. O'Reilly (NRC), "Surry and North Anna Power Stations Review of Boron Dilution Events," Serial No. 266, dated June 1, 1981.

8. Letter from S. A. Varga (NRC) to J. H. Ferguson (Vepco), Response to Letter regarding "Review of Boron Dilution Events," Serial No. 266, dated June 8, 1981.