VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

February 8, 1991

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

Serial No. 90-746A
NL/RPC
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
REQUEST FOR ADDITIONAL INFORMATION
PROPOSED TECHNICAL SPECIFICATION CHANGE
BORON CONCENTRATION INCREASE

Pursuant to 10 CFR 50.90, in a letter (Serial No. 90-746) dated December 21, 1990, Virginia Electric and Power Company requested 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. In a telephone conversation on January 28, 1991, questions were raised by the NRC technical reviewers.

Attachment 1 provides additional discussion of the proposed changes and addresses the specific questions raised. Should you require further information, please contact us.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Attachment

A001

cc: U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N. W.
Suite 2900
Atlanta, Georgia 30323

Mr. W. E. Holland
NRC Senior Resident Inspector
Surry Power Station

Commissioner
Department of Health
Room 400
109 Governor Street
Richmond, Virginia 23219

ATTACHMENT 1

RESPONSE TO NRC
QUESTIONS OF
JANUARY 28, 1991

INTRODUCTION

Virginia Power operates four nuclear units, two at North Anna and two at Surry. It has been the Company's outage planning philosophy to stagger outages whenever possible in order to avoid the load management, logistical, and economic disadvantages associated with concurrent outages. In order to accomodate this outage planning philosophy, the fuel management plan for each unit provides for flexibility in the final end-of-cycle burnup including the use of power coastdowns. It has been our experience that we are using this built-in flexibility and are performing end-of-cycle power coastdowns routinely.

While end of cycle power coastdowns are fully evaluated from a safety analysis perspective, they represent an off-nominal operational mode which is undesirable from the standpoint of maximizing electrical generation. Designing reload cores with increased initial core reactivity is one means to reduce the need for extended end-of-cycle coastdowns. In the upcoming Surry 2 Cycle 11, for example, we are designing and analyzing a core which includes 8 additional fresh fuel assemblies. This would increase the feed to this cycle from the previously planned 56 assemblies to 64 assemblies, thereby increasing overall cycle burnup capability. These additional fuel assemblies have been procured for Surry 2, Cycle 11.

IMPACT ON SOLUBLE BORON CONCENTRATIONS

Increased initial core reactivity requires additional reactivity holddown at beginning of cycle. For Virginia Power cores, reactivity holddown is achieved using a combination of Burnable Poison Rod Assemblies (BPRA's) and soluble boron in the coolant system. A review of the reactivity holddown requirements associated with the planned fuel management scheme for Surry 2 Cycle 11 and future cores for both Surry units indicated that additional soluble boron would be required. A series of engineering evaluations were initiated to determine the impact of increased boron concentration on the existing plant safety analyses, Technical Specifications, operating procedures, and physical systems. The Proposed Technical Specification Change and associated Safety Evaluation provide a summary of those engineering evaluations.

Our proposed increase in the refueling boron concentration from 2000 ppm to 2300 ppm will provide approximately 3500 pcm (3.5%) of additional reactivity holddown capability at beginning of cycle, which could accomodate core designs with up to approximately 100 effective full power days (EFPD) of full power reactivity life beyond that associated with current designs. However, other design or safety analysis constraints (such as the beginning of cycle (BOC) positive moderator temperature coefficient (MTC)) will replace the refueling concentration limit as the most restrictive parameter and would be expected to limit the increase in full power reactivity life to less than 100 EFPD.

DESIGN CONSTRAINTS AT REFUELING CONDITIONS

Increased initial core reactivity is constrained by Technical Specification 3.10A, Refueling, and its associated basis, which requires a maximum k-effective during refueling of 0.95. Virginia Power confirms that this limit (including appropriate uncertainties) is met for refueling boron corresponding to the minimum concentration requirement of Specification 3.10A.9(b) (currently 2000 ppm) for every reload design. This concentration also corresponds to the minimum required concentration of the refueling water storage tank.

In addition to the evaluation of normal refueling k-effective, the reload design process also confirms that the reactor remains subcritical with all control rods removed at refueling boron concentration and cold conditions. (This criteria is based on a conservative application of General Design Criterion 26).

Increased boron concentrations at both refueling and operating conditions also have the potential to impact key assumptions in the boron dilution accident analyses, as will be explained more fully in subsequent sections.

ACCIDENT ANALYSIS IMPACT

Virginia Power's reload design methodology is documented in Reference 1. As discussed therein, our basic philosophy is to establish a detailed set of design constraints based on the Technical Specifications, the UFSAR accident analysis input assumptions and the fuel management plan and then to design and operate our cores within those constraints. The proposed changes therefore do not represent the characteristics of any specific core design, but rather provide a new envelope of design constraints, supported by appropriate safety analyses, to be utilized in the design process for future core reloads.

Based on our experience with past reload cores, we have developed estimates of the increases in critical boron concentration at various core conditions which would result from a typical core designed to the new refueling boron constraint (i.e. k-effective = 0.95 at 2300 ppm). Based on these estimates, we then reanalyzed the affected UFSAR accident analyses (principally the boron dilution events) to demonstrate continued compliance with the appropriate safety acceptance criteria. For the boron dilution events, the calculated time to criticality and/or loss of shutdown margin for events initiated from each operational mode remains bounded by the applicable acceptance criterion, as discussed in Attachment 1 of our letter dated December 21, 1990. The input assumptions to these analyses will become part of the constraining criteria for future reload core designs. Critical boron concentration is of course only one result of designing more reactive reload cores (i.e. higher number of feed assemblies). Other related parameters such as beginning of cycle moderator temperature coefficient will also be impacted. These changes are assessed against the accident analyses in accordance with the Reference 1 methodology.

IMPACT ON BORON DILUTION ACCIDENT AT COLD SHUTDOWN

As discussed above, the boron dilution events from various operational modes were reanalyzed to establish new core parameter limits to be used as design constraints for upcoming core reloads. Core characteristics, such as critical boron concentration were assumed which are expected to bound upcoming cycle designs, including Surry 2 Cycle 11. This assessment is confirmed for each reload design as part of the normal reload design and safety evaluation process. These analyses are described in Attachment 1 of our letter dated December 21, 1990. To provide further amplification, the analysis for cold shutdown is discussed in more detail below.

Surry Power Station currently establishes an administrative shutdown margin requirement for shutdown operations. The intent of this shutdown margin requirement is to provide for a minimum of 15 minutes of operator action time to respond to an inadvertent boron dilution event prior to reactor criticality. The shutdown margin requirement is established based on the limiting configuration of the reactor at cold shutdown with energy being removed by the residual heat removal system. This approach was documented to the Commission in References 2 and 3. In actual practice, this administrative requirement has been imposed whenever the reactor is shut down, even though the limiting configuration for which the numerical value of the administrative shutdown margin limit is established (cold shutdown, RHR operation) will not always be present. The current administrative limits are set at 5.5% delta-k/k for cycle burnups of less than to 9000 MWD/MTU and 4.0% delta-k/k for cycle burnups exceeding 9000 MWD/MTU. The burnup dependence results from the fact that critical boron concentrations reduce, and therefore postulated dilution events become less limiting, as burnup increases. This dependency on critical boron concentration is discussed more fully herein.

Boron dilution during RHR operation is of particular interest because the effective RCS volume being diluted is reduced with respect to other modes of operation where one or more reactor coolant pumps are operating. With RCP operation, any incoming dilution flow would be mixed with the entire RCS volume, including the loops and the steam generators. In the case of RHR operation, the loops and steam generators are essentially stagnant. Therefore, during RHR operation, boron dilution rates can be higher for a given primary grade water addition rate than for the other operational modes.

There are basically two options for dealing with the boron dilution event at cold shutdown. The first option, which is currently specified in North Anna Technical Specifications, is to preclude the event by requiring that the source of primary grade water be locked, sealed or otherwise secured in the closed position except during planned dilution or makeup activities. The other option is the imposition of added shutdown margin requirements discussed above.

There are operational advantages and disadvantages associated with each option. Use of the lockout feature involves added personnel requirements to unlock and relock the valve during dilution and makeup activities. In addition, because radiation fields in the vicinity of the chemical and volume control system equipment can be significant, there are ALARA concerns. On the other hand, use of the administrative shutdown margin eliminates these problems but can involve significant additional processing of reactor coolant due to the high boron concentrations involved. Based on these considerations, the administrative shutdown margin approach had been previously chosen as the option for Surry.

The administrative shutdown margin (SDM) limits were developed based on selection of conservative core physics characteristics which were expected to bound anticipated reload cores. This was done to avoid the requirement for routine revision of the SDM operating procedure with every reload.

The calculational basis for developing the administrative SDM is as follows. Assuming a conservatively high addition rate of primary grade water of 300 gpm (calculations showed an upper limit of about 250 gpm for this flow), the amount of boron dilution which could occur in the effective portion of the RCS in 900 seconds (15 minutes) was calculated. The result was that a 20% dilution (final concentration = 0.8 x the initial concentration) can occur in 900 seconds.

A combined expression for the required SDM is thus as follows:

$$SDM = -(CB,Crit/0.8 - CB,Crit) \times ALPHAB / 1000 \qquad (1)$$

where

SDM = required shutdown margin, %

CB,Crit/0.8 = Required boron to yield 15 minutes of dilution time

CB,Crit = Critical boron concentration, CZP,ARI

ALPHAB = differential boron worth, pcm/ppm

1000 = conversion, pcm to % delta-k/k

Review of (1) shows that the shutdown margin is directly proportional to the critical boron concentration and differential boron worth for a given core. Conservative parameter directions for selecting key parameters for determining the required SDM are therefore: high CB,Crit, high ALPHAB.

<u>CB,Crit</u>

- A bounding, high value for the cold zero power critical boron concentration was used to calculate the required initial boron concentration to allow 15 minutes of dilution to criticality. The value of CZP critical boron chosen was 1350 ppm. Table 1, attached, compares this value to some recent reload values.

<u>ALPHAB</u>

- A bounding, high value of differential boron worth of -16.0 pcm/ppm was used to calculate the required shutdown margin associated with borating from 1350 ppm to 1350/0.8 = 1687.5 ppm. Table 2, attached, compares this value to some recent reload values.

Inserting these values into Equation (1) yields a SDM requirement of - 16.0 x (1687.5 - 1350) = 5400 pcm or, rounding up to the nearest 1/2%, = 5.5% at beginning of cycle. Note that this requirement is considerably in excess of either the 1% subcriticality or the 1.77% shutdown margin requirement (subcriticality + reactivity worth of withdrawn control and shutdown banks) defined in the Technical Specifications for cold shutdown operation.

Note also from Tables 1 and 2 that current cycle designs have had considerable margins for both key parameters with respect to the values assumed in establishing the administrative requirement.

However, as discussed previously, Virginia Power anticipates loading more reactive cores in future cycles. As a result, the critical boron concentration CB,Crit will be expected to increase, and therefore the administrative shutdown margin requirements will also increase. As a first approximation, we would expect increases in critical boron on the order of 300 ppm, i.e. equivalent to the proposed refueling concentration increase. Therefore, from equation (1), the administrative shutdown margin requirement would also be expected to increase by about 22% (1650/1350 = 1.22).

In view of the high boron concentrations already being used during cold shutdown, the projected increase in this requirement for future cycles, as well as the recent reductions in the radiation fields in the chemical and volume control system equipment areas, we are now proposing to replace the administrative shutdown margin approach to addressing boron dilution events with the Technical Specification approach which requires lockout of the primary grade water source. As noted before, the Technical Specification approach is similar to that used at North Anna and other facilities.

IMPLEMENTATION OF PRIMARY GRADE WATER LOCKOUT

Although the Surry units were not licensed under the NRC Standard Review Plan (SRP), the SRP states that there should be at least 30 minutes available at refueling conditions between positive indication of a moderator dilution in progress to loss of shutdown margin for corrective operator action. At cold shutdown through at-power conditions, the SRP specifies that at least 15 minutes must be available between positive indication of a moderator dilution in progress to loss of shutdown margin. To meet the intent of the NRC Standard Review Plan, and to avoid the excessive shutdown margin requirements discussed in the previous section, Virginia Power is proposing that the primary grade water flow path be locked out during refueling and cold shutdown conditions. This action will procedurally prevent a boron dilution event from occurring during refueling and cold shutdown conditions.

According to the current Surry Operating Procedure OP-4.1 (Controlling Procedure for Refueling), the flow path for primary grade water to the chemical and volume control system (CVCS) is isolated during refueling conditions. This precludes the possibility of an inadvertent boron dilution at refueling conditions. It is proposed that this administrative isolation of the primary grade water flow path be made a Technical Specification requirement. Specifically, during all refueling operations, manual valve 1-CH-223 (2-CH-223 for Unit 2), the primary makeup water control valve, will be isolated and physically locked in the closed position within 15 minutes following a planned dilution. This ensures that the source of primary grade water is completely isolated from the reactor coolant system. Alternately, manual valves 1-CH-212, 1-CH-215 and 1-CH-218 (2-CH-212, 2-CH-215, and 2-CH-218 for Unit 2) may be isolated and physically locked shut if for any reason it is necessary to maintain 1-CH-223 (2-CH-223) open. This alternative combination of valve lockouts has the same effect as locking out valve 1-CH-223 (2-CH-223). Operating procedures for cold shutdown conditions will be revised to require similar measures.

A combination of two or more of the following mechanical or procedural failures would have to occur to circumvent the above-described measures and permit an inadvertent boron dilution: (1) The manual valve 1-CH-223 (or 2-CH-223), or the alternate equivalent combination of valves which are normally preventing the flow of PG water, would have to fail. (2) The primary grade water flow control valve, FCV-1114A, which fails closed and is normally in a position which prevents the flow of PG water, must bind in the open position. (3) From a procedural standpoint, there would have to be a failure to lock out manual valve 1-CH-223 (or 2-CH-223) or the alternate equivalent combination of valves. (This would also be in violation of Technical Specifications.) (4) The operating procedures governing planned moderator dilution would have to be circumvented to allow the occurrence of a dilution event which leads to loss of shutdown margin.

The currently implemented approach of assuring adequate shutdown margin to provide for operator response time in the event of an inadvertant boron dilution event will continue to be used for operation at intemediate and hot shutdown and for power operation. Evaluation of the boron dilution event in these modes is presented in Attachment 1 of our letter dated December 21, 1990.

REFERENCES

1. Virginia Power Topical Report, VEP-FRD-42, Rev. 1-A, Reload Nuclear Design Methodology, September 1986.

2. 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.

3. 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.

TABLE 1
COLD ZERO POWER CRITICAL BORON CONCENTRATION

CYCLE	CZP CRITICAL BORON, PPM
S2C10	1188
S1C10	1176
S2C9	1113
S1C9	1146
S1C8	913
Assumed to set SDM Requirements	1350

TABLE 2
COLD ZERO POWER DIFFERENTIAL BORON WORTH

CYCLE	CONDITION	DIFFENTIAL WORTH, PCM/PPM
S2C10	BOC,CZP,Critical,No Xe, ARI	- 10.38
	EOC,CZP,Critical,No Xe, ARI	- 12.87
S2C9	BOC,CZP,Critical,No Xe, A-D In	- 10.48
	EOC,CZP,Critical,No Xe, A-D In	- 13.16
S1C10A	BOC,CZP,Critical,No Xe, ARI	- 10.72
	EOC,CZP,Critical,No Xe, ARI	- 13.15
S1C9	BOC,CZP,Critical,No Xe, A-D In	- 10.47
	EOC,CZP,Critical,No Xe, A-D In	- 13.32
____	Assumed to set SDM requirements	- 16.0