VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

10 CFR 50.90

January 22, 2004

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

Serial No. 03-313K
NLOS/ETS
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

**VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
NORTH ANNA POWER STATION UNITS 1 AND 2
PROPOSED TECHNICAL SPECIFICATIONS CHANGES AND EXEMPTION REQUEST FOR USE OF FRAMATOME ANP ADVANCED MARK-BW FUEL
SUPPLEMENTAL INFORMATION FOR REALISTIC LARGE BREAK LOSS OF COOLANT ACCIDENT (RLBLOCA) CONTAINMENT PRESSURE ANALYSIS AND POST ACCIDENT RADIATION HEAT TRANSFER IN THE FUEL ASSEMBLIES**

In a May 6, 2003 letter (Serial No. 03-313) Dominion submitted the Realistic Large Break LOCA (RLBLOCA) results for Advanced Mark-BW fuel in North Anna Unit 2 to support the NRC's review of a proposed amendment and exemptions that will permit North Anna Units 1 and 2 to use Framatome ANP Advanced Mark-BW fuel. On August 20, 2003 (Serial No. 03-313A) Dominion provided a response to an August 6, 2003 NRC request for additional information regarding the RLBLOCA results. In an August 28, 2003 meeting to discuss the RLBLOCA analysis results, the NRC staff requested further clarification of Dominion's August 20, 2003 responses. Supplemental information was provided for Questions 1, 5, 9, and 10b on September 5, 2003 (Serial No. 03-313C), Questions 6 and 11a on September 22, 2003 (Serial No. 03-313D), Questions 2, 3, and 4 on September 26, 2003 (Serial Nos. 03-313E and F), Questions 2, 4, 10a, 10b and containment modeling on November 10, 2003 (Serial No. 03-313G), and December 8, 2003 (Serial No. 03-313H), and Question 4 on December 17, 2003 (Serial No. 03-313I), and further containment modeling on January 6, 2004 (Serial No. 03-313J). In a follow up telephone call conducted on January 8, 2004 regarding containment modeling, the NRC Staff requested additional information regarding the modeling of Safety Injection flow and its effect on the containment pressure analysis. In addition, a question regarding radiation heat transfer modeling for RLBLOCA was provided by facsimile on January 13, 2004.

The attachment to this letter provides the requested information. As noted in our August 20, 2003 letter, this information is applicable to both North Anna Units 1 and 2 even though the RAIs received were specific to Unit 2.

To support the use of Framatome Advanced Mark-BW fuel in North Anna Unit 2, Cycle 17, we respectfully request the NRC to complete their review and approval of the

A001

license amendment by February 29, 2004. We appreciate your consideration of our technical and schedular requests.

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

Very truly yours,

Leslie N. Hartz
Vice President – Nuclear Engineering

Attachment

Commitments made in this letter: None

cc: U.S. Nuclear Regulatory Commission
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SN: 03-313K
Docket Nos.: 50-338/339
Subject: Proposed Technical Specifications Changes and Exemption Request
Framatome ANP Advanced Mark-BW Fuel

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 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 22nd day of January, 2004.

My Commission Expires: 3/31/04.

Maggie McClure
Notary Public

(SEAL)

Attachment 1

Supplemental Information for Realistic Large Break Loss of Coolant Accident (RLBLOCA) Containment Pressure Analysis and Post Accident Radiation Heat Transfer in the Fuel Assemblies

Realistic Large Break LOCA Analysis Results – North Anna

Framatome Fuel Transition Program
Technical Specification Change

Virginia Electric and Power Company
(Dominion)
North Anna Power Station Units 1 and 2

Supplemental Information for Realistic Large Break Loss of Coolant Accident (RLBLOCA) Containment Pressure Analysis And Post Accident Radiation Heat Transfer in the Fuel Assemblies

In an August 28, 2003 meeting and subsequent telephone conference calls, the NRC staff requested additional information to supplement the responses provided in Dominion's August 20, 2003 letter (Serial No. 03-313A). In letters dated September 5, 2003 (Serial No. 03-313C), September 22, 2003 (Serial No. 03-313D), September 26, 2003 (Serial Nos. 03-313E and F), November 10, 2003 (Serial No. 03-313G), December 8, 2003 (Serial No. 03-313H), December 17, 2003 (Serial No. 03-313I), and January 6, 2004 (Serial No. 03-313J) the supplemental information was provided to the NRC. In follow up telephone calls conducted on January 8, 2004 regarding containment modeling, the NRC Staff requested additional information regarding the modeling of Safety Injection flow and its effect on the containment pressure analysis. In addition, a question regarding radiation heat transfer in the fuel was provided by facsimile on January 13, 2004. This requested information is provided below. The response is applicable to both North Anna Units 1 and 2, even though the original RAIs received were specific to Unit 2.

NRC Question - Rod-To-Rod Radiation Heat Transfer

The NRC staff has developed an example of a thermal radiation problem that could be used to justify the use of the RELAP 5 radiation model presented in Topical Report 2103(P), Revision 0, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors."

A. In this example, a 6x6 array of rods in the hot bundle are selected, with the following bounding conditions presented below.

1. The limiting rod is located in position #16 roughly in the center of the array.
2. The limiting rod peak cladding temperature (PCT) is 2032°F.
3. All remaining rods in the array are at a temperature of 1975°F.
4. The fence is at a temperature of 1975°F.
5. No guide tubes were modeled in this array.

Using these bounding conditions in this example, the minimum equivalent heat transfer coefficient for rod no. 16 is calculated to be 2.6 Btu/hr-ft^2-°F. This value bounds the FLECHT test data equivalent heat transfer coefficients of 1.87, 2.22, and 1.90 Btu/hr-ft^2-°F for FLECHT Tests 31504, 13609, and 13914, respectively. The temperature value of 1975 F for all of the rods surrounding the hot rod bounds the power distribution in the vicinity of the PCT rod. Specifically, a pin census would show that the difference in peaking factors between the hot rod and the rods surrounding the hot rod (nearest neighbors) is bounded by the 1975°F temperature assumed for the neighboring rods. If the hot rod temperature is 2032°F and the average hot bundle temperature is 1838°F, then the use of the actual peaking factors for the hot rod and the rods surrounding the hot rod would result in rod temperatures lower than 1975°F. This demonstrates that rod temperatures, in the intermediate range between the highest temperature rod and the average hot bundle temperature, can be obtained by interpolating both the peaking factors and the associated temperatures from the highest temperature rod and the average hot bundle temperature along with their associated peaking factors.

Note, in the above example, the highest temperature rod is rod #16 with a temperature of 2032°F and peaking factor of F_{hr}. The temperature of the average bundle rod is 1838°F with a peaking factor of F_{ave}. If the actual peaking factors for the rods surrounding the hot rods are used to generate their temperatures (something in the intermediate range between F_{hr} and F_{ave}), this cause temperatures to be lower than the assumed neighboring temperatures of 1975°F. Thus, the chosen power distribution (or temperatures of neighboring rods) bounds the PDQ pin census distributions during the fuel cycle.

B. Regarding its proposed license amendment to implement Framatome Advanced Mark-BW Fuel at North Anna Power Station, Units 1 and 2, Virginia Electric and Power Company is requested to confirm that the separation in power between the highest temperature rod and the surrounding rods bounds the power distribution for potential peak temperature rod locations in the core (i.e all rods in the hot bundle within the physics uncertainty on peaking factor) during the entire fuel cycle.

Response

To respond to this request, an analysis was performed to calculate the minimum expected radiant heat transfer for the hot rod by assuming a minimum separation of power between the hot rod and the neighboring rods in the hot assembly. The minimum separation of powers condition for an Advanced Mark-BW assembly would exist if the power for adjacent rods differs from the hot rod power by an amount equal to the assumed radial power uncertainty. The calculation of rod temperatures is performed by first quantifying the applicable rod power and then identifying the corresponding rod and assembly temperatures. The radial power factors for the hot rod and the hot assembly for the limiting RLBLOCA calculation are 1.65 and 1.511, respectively. The radial power uncertainty is 4%; hence, the minimum separation of powers (i.e., the maximum adjacent rod power) possible in a RLBLOCA calculation is just the hot rod value adjusted by 4% or

$$F_{nom} = \frac{1.65}{1.04} = 1.587$$

Interpolating the hot rod and hot assembly temperatures over the power range, the corresponding temperature at the F_{nom} value is

$$\left(\frac{F_{hr} - F_{nom}}{F_{hr} - F_{ave}}\right) = \left(\frac{T_{hr} - T_{nom}}{T_{hr} - T_{ave}}\right) \Rightarrow \frac{1.65-1.587}{1.65-1.511} = \frac{2{,}032 - T_{nom}}{2{,}032-1{,}838} \Rightarrow T_{nom} = 1{,}944\ {}^{\circ}F.$$

Examining the results from the previous calculation for minimum assembly radiation, the location of minimum rod-to-rod radiation was Pin 11 as shown in Figure 1. Pin 11 was selected as the initial location for use in this calculation, which investigates the influence of rod location on the calculated minimum rod-to-rod radiation.

Figure 1. Location of Pin Number 11 in the 6x6 Assembly Array.

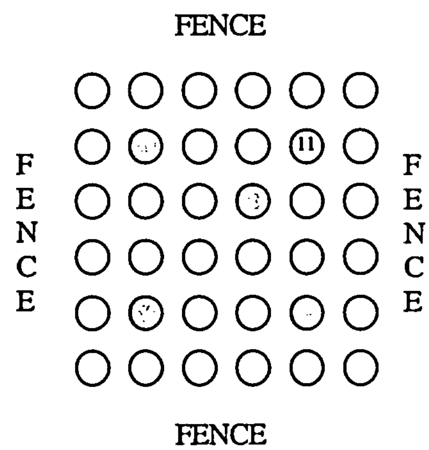

Table 1 presents the temperature input for this problem. A key difference from the previous calculations is that the fence temperature is conservatively increased to the original hot assembly temperature.

Table 1. Temperatures for Minimum Separation of Powers Analysis.

Temperatures	°F
Hot Rod	2,032
Hot Assembly	1,944
Guide Tube	1,650
Boundary (Fence)	1,838

The calculation results are provided in Table 2. The hot rod radiant heat transfer coefficient is given at Pin 11. Both the assembly average and hot rod results bound the results generated for the FLECHT-SEASET and FLECHT-SKEWED studies. A subsequent PDQ census (i.e., tests at other locations) confirms that performing the analysis at Pin 11 provides the minimum hot rod heat transfer coefficient.

Table 2. R2RRAD Code Results: North Anna Minimum Radiant Heat Transfer.

Case	Assembly Average HTC (BTU/hr-ft^2-R)	Hot Rod HTC (BTU/hr-ft^2-R)
North Anna (min)	2.5	5.36

In the context of the NRC-provided example given in part A, the T_{nom} value of 1,944°F from the North Anna RLBLOCA calculations is the measure of comparison to the stated NRC 1,975°F figure of merit. Given that the Advanced Mark-BW specific minimum HTC results (evaluated using a T_{nom} value of 1,944°F) satisfy the generalized problem, it can be stated that the North Anna RLBLOCA calculation conservatively treats thermal radiation effects.

NRC Question from January 8, 2004 Telephone Conference Call

Describe treatment of Safety Injection, including the accumulator water, which spills to containment during cold leg break LOCA. How does this Safety Injection spillage interact with the containment atmosphere and affect its temperature and pressure?

In discussions with NRC staff during a January 12, 2004 teleconference, additional clarifications were provided regarding the modeling of ECCS and its interaction with the containment atmosphere. NRC staff requested that those clarifications be provided in writing. This response fulfills that request.

Response

Safety Injection flow modeling was partly addressed by the following paragraph taken from the attachment to Dominion letter 03-313G (see page 3), dated November 10, 2003. It states that no ECCS flow spills to containment in the RBLOCA model. This modeling incorporates the approved RLBLOCA model and is also denoted in Table 1 of the same Dominion letter. In addition, Framatome ANP again separately confirmed that no ECCS injection is spilled directly to containment in the RLBLOCA model.

"ECCS injection is modeled in a manner consistent with the realistic LBLOCA evaluation model requirements: all ECCS is injected into the NSSS. The resistance network determines the ECCS that is discharged into the containment through the break. No ECCS is spilled directly to the containment."

In the RLBLOCA model, the ECCS is injected into the cold leg through flow junctions modeled directly from the North Anna plant design. In the cold leg, including the broken cold leg, the ECCS fluid mixes with the predominantly steam flow in the RCS. In the broken cold leg, the steam and fluid are then discharged out the break to the containment atmosphere. The break flow, both steam and liquid components, is added directly to the containment atmosphere, and is modeled to achieve instantaneous equilibrium. Because of this treatment, there is no effective difference between allowing the mixing to occur in the cold leg prior to discharge from the break and mixing the steam and liquid flows separately in the containment atmosphere. The degree to which the ECCS is heated in the mixing process in the cold leg is counterbalanced by de-superheating of the steam flow. Were the ECCS modeled as direct spillage, a realistic treatment would represent spillage to the containment floor versus the clearly conservative instant equilibrium in the containment atmosphere assumed in the RLBLOCA model, which effectively treats the ECCS fluid as an additional containment spray.