Virginia Electric and Power Company
Richmond, Virginia 23261

March 26, 1981
Serial No. 195
NO/RMT:smv
Docket Nos. 50-280
50-281
50-338
50-339
License Nos. DPR-32
DPR-37
NPF-4
NPF-7

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

SUPPLEMENTARY INFORMATION FOR
SURRY POWER STATION UNITS NO. 1 AND 2 AND
NORTH ANNA POWER STATION UNITS NO. 1 AND 2
PROPOSED TECHNICAL SPECIFICATIONS CHANGE

In our letters dated May 15, 1980 (Serial No. 400) and March 6, 1981 (Serial No. 109), we proposed changes to the Technical Specifications for Surry Units No. 1 and No. 2 and North Anna Units No. 1 and No. 2 to permit an increase in the enrichment limit for new fuel.

In response to a verbal request from a member of your staff, Vepco agreed to provide answers to several questions on the effects of extended fuel burnups on accident source terms and iodine spiking. These answers are provided in Attachment 1.

If you require any additional information, please contact this office.

Very truly yours,

BRSylvia

B. R. Sylvia
Manager - Nuclear
Operations and Maintenance

Attachment

cc: Mr. James P. O'Reilly
Office of Inspection and Enforcement
Region II

Mr. Robert A. Clark, Chief
Operating Reactors Branch No. 3
Division of Licensing

Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

A001
5
1/40

P

Question 1: What is the effect of burnups above 33,000 GWD/MTU on accident source terms?

Response: Table I shows core activities for North Anna 17x17 fuel at 33 and 38 GWD/MTU. These activities were determined from ORIGIN calculations using the ENDF B IV Library. The fuel was assumed to be enriched to 4.1% and the plant was assumed to be operated at 2900 MWt for the calculation. Table II lists the gap fractions calculated with the ANS 5/4 model at burnups of 20 and 38 GWD/MTU. The Table II calculations are consistent with core activities shown in Table I and the parameters assumed in the calculation of these fractions are also shown in Table II.

In Table I it can be seen that the burnup increase causes either a decrease in activity or an insignificant increase for most isotopes. In the case of the noble gas isotopes, either the small inventory present or the small contribution to the total dose result in a minor impact on accident consequences. However, more limiting core activities were assumed in the North Anna FSAR for the noble gases, as shown in Table I. The fission product core iodine inventories given in Table I are higher than those in the North Anna FSAR due to:

a) the use of a 4.1% enrichment

b) the use of the ENDF B/IV fission product data library.

The values in the North Anna FSAR were taken from the

TID-14844 document. However, the overall radiological consequences of postulated accidents should not change to any significant degree if another model update is also used. The North Anna FSAR used iodine dose conversion factors(DCFs) from TID-14844 while current practice is to use those values in the NRC Regulatory Guide 1.109. The decrease in DCF values for iodines will offset the minor increase in the iodine inventories and thus leave the FSAR results virtually unchanged.

Table II shows a large drop in the gap fractions with burnup. The parameters which drive diffusion of fission gases from the fuel to the gap are fuel temperature and burnup. Fuel temperature reductions with increasing burnup more than offset the effect of increasing burnup on diffusion rates.

Tables I and II show that accident source terms(core and gap) either decrease or have an insignificant increase with higher burnups. In either case, the radiological consequences of the FSAR accidents remain unchanged. While the specific calculations were performed for a North Anna 17x17 core, the minor changes with burnup are representative of both plants and therefore Surry specific calculations are not needed. Specifically, Surry fuel would exhibit the same phenomena exhibited by the North Anna extended burnup calculations, i.e. minor increases in the iodines that can be offset by lower DCF's and lower gap fractions due to reduced fuel temperatures.

Table I

Noble Gas and Iodine Core Inventories at Shutdown

(Values are in Curies)

Basis / Radionuclide	33000 MWD/MTU	38000 MWD/MTU	Assumed in North Anna FSAR
Noble Gases			
Kr-85	5.33×10^5	6.02×10^5	8.14×10^5
Kr-85m	2.42×10^7	2.33×10^7	3.22×10^7
Kr-87	4.54×10^7	4.34×10^7	6.19×10^7
Kr-88	6.44×10^7	6.17×10^7	8.82×10^7
Xe-133	1.57×10^8	1.58×10^8	1.66×10^8
Xe-133m	2.35×10^7	2.35×10^7	4.22×10^6
Xe-135	3.85×10^7	3.74×10^7	4.54×10^7
Xe-135m	3.11×10^7	3.17×10^7	4.45×10^7
Iodines			
I-131	7.74×10^7	7.84×10^7	7.17×10^7
I-132	1.138×10^8	1.148×10^8	1.09×10^8
I-133	1.654×10^8	1.652×10^8	1.61×10^8
I-135	1.538×10^8	1.534×10^8	1.46×10^8

TABLE II

Fuel Rod Gap Fractions For Lead Burnup

Fuel Assembly Discharged at Refueling

Nuclide	ANS 5/4 Model 20,000 MWD/MTU	ANS 5/4 Model 38,000 MWD/MTU
I-131	0.086	0.0012
I-133	0.029	0.00038
I-135	0.016	0.00022
Xe-133	0.027	0.00036
Xe-135	0.0073	0.000096
Xe-138	0.0013	0.000017
Kr-85m	0.0051	0.000066
Kr-85	0.12	0.080
Kr-87	0.0027	0.000036
Kr-88	0.0041	0.000053

Parameters used to calculate fuel rod gap fractions of lead assembly

Core Average Power	5.44 kw/ft
Radial Peaking Factor	
20,000 MWD/MTU	1.25
38,000 MWD/MTU	1.07

TABLE II (CONT)

Fuel Temperature[1]	
20,000 MWD/MTU	1422°K
38,000 MWD/MTU	977°K
Gap Fraction Model[2]	ANS 5/4

[1] Taken as fuel centerline temperature at lead rod power.

[2] ANS 5/4 model used except the entire fuel assembly was modelled to be at one uniform temperature. The temperature chosen to conservatively apply this model was the fuel centerline temperature of the lead rod in the assembly with the burnup noted.

Question 2: What are the bases for any decontamination factors used in consequence evaluations?

Response: The decontamination factors (DFs) used in the North Anna and Surry FSAR analyses are discussed in Sections 15.4.5.2.3 and 14.4.1.2 of their respective FSAR's. The correlation used to calculate the North Anna DF was developed from small and large scale tests. The DF is an exponential function of the the bubble rise time (or pool depth) and the effective bubble diameter (calculated from the total volume of gas released from the fuel assembly gaps). With consideration given to the total volume of gas released from a fuel assembly, i.e., 6.9 SCF for the North Anna 15x15 array (the volume of release would be much smaller for a 17x17 array due to its lower fuel temperatures), the pool decontamination factor was indicated in the FSAR to be a minimum of 760 for the 26 foot pool. However, for conservatism a DF of 100 was used in the evaluation of the fuel handling accident. An even more conservative value of 10 was used in the Surry FSAR analysis.

As previously discussed, the gap fractions shown in Table II are much decreased due to the effect of decreasing temperature with burnup. Consequently, previous margins in the DF and the reductions in the gap fractions offset any uncertainty associated with higher back pressures, bubble size, etc., at higher burnups, and the fuel handling accident analyses presented in the FSARs remain conservative.

Question 3: What are the radiological consequences of accidents?

Response: Since the changes in the source terms and gap fractions discussed in the reponses to questions 1 and 2 are insignificant, the radiological consequences of the licensing analyses remain bounding.

Question 4: How does the iodine spiking behavior for fuel burnups greater than 33,000 MWD/MTU compare to that for present models?

Response: The prevailing theory on the thermal and hydraulic mechanisms producing the iodine spiking phenomena is the result of independent investigations in both the United States and abroad. The theory describes the probable source of the spike inventory as cesium iodide salts which are deposited on the inner surfaces of the fuel rod cladding and to a lesser degree on the outer surface of the fuel pellets. A fuel rod with a cladding defect will admit reactor coolant liquid to contact the inner surfaces of the fuel rod only when the local power is below approximately 2 kw/ft. When reactor coolant enters the fuel rod, it will dissolve the cesium iodide salts deposited there. The dissolved cesium and iodine are then free to be transported to the reactor coolant system where the iodine is seen as an iodine spike. A similar hydraulic mechanism occurs during reactor coolant depressurization wherein the trapped gases within the fuel rod above and/or below the defect location will be at a higher pressure than the coolant as the reactor coolant system is depressurized. This creates a driving head to expel the iodine ladden water from the fuel rod thus producing another iodine spike. These spikes have become known as power spikes and pressure spikes.

Since the source of iodine has been shown to be the fuel rod cladding gap activity, any spike activity resulting from fuel rods with high burnup(i.e. greater than 33,000 MWD/MTU) would be less than that from defected rods at lower burnup due to the decreasing gap inventory as shown in the answer to question 1. Additionally, the spiking data upon which the present quantatative NRC model has been developed does not include local burnup of the defected fuel rods. It is not possible to ascertain the burnup or temperature history of the defected fuel rods producing the spikes on which data is available. Therefore, it is believed that it is inappropriate to attempt to model the iodine spiking phenomena for variations in burnup.

The only effect of higher burnups on iodine spiking would result from the lower linear power of high burnup fuel rods. If a defected fuel rod were at a high burnup level, the linear power of the fuel rod would be closer to 2 kw/ft compared to lower burnup fuel rods. Thus a smaller decrease in reactor power would be necessary in order to produce an iodine spike of the power spike variety. This implies two observations:

1. Upon reactor shutdown, the spike contribution from high burnup fuel rods would be produced earlier in the shutdown transient than that contribution from defected rods at lower burnups

2. Iodine spikes would be produced with smaller power variations (e.g. smaller load follow swings) if defected rods were at high burnup as compared to defected rods at lower burnups.

However, since the use of the iodine spiking phenomena in Safety Analysis Reports and Safety Evaluation Reports is in the area of radiological consequences of accidents, this effect would not affect the results of the analyses. In accident scenarios, a reactor trip occurs thereby resulting in all fuel rods dropping below 2 kw/ft at roughly the same time. In this case, high burnup rods would not produce an early spike component.

In conclusion, it is believed that the NRC spiking model remains conservative in dealing with iodine spiking when considering fuel rod defects in high burnup fuel rods.