Florida Power
CORPORATION

June 29, 1979

Mr. Robert W. Reid
Chief
Operating Reactors Branch #4
Division of Operating Reactors
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Crystal River Unit 3
Docket No. 50-302
Operating License No. DPR-72
High Density Fuel Racks

Dear Mr. Reid:

In our letter of March 16, 1979, Florida Power Corporation submitted information on the suitability of the B4C Composite poison material proposed for the Crystal River high density fuel storage racks. This information, submitted in response to specific NRC questions regarding the Crystal River fuel rack licensing amendment, was based on the partial results of an extensive test program developed and implemented by the B4C Composite material supplier, the Carborundum Company. The Test Program was comprised of four parts as follows:

a. Short Term Test (simultaneous exposure of B4C materials, to a gamma radiation level of 10^{10} Rads and prototypical fuel pool water environments both deionized water and borated water).

b. Offgassing Test.

c. Leachability Test.

d. Long Term Test (simultaneous exposure of B4C materials to a gamma radiation level of 10^{11} Rads and deionized water).

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The results of the first three parts of the Test Program were presented in Carborundum Report CBO-N-78-299 which was submitted as a proprietary report by the Connecticut Yankee Power Company under Docket 50-218 and the Northeast Nuclear Energy Company under Docket 50-245. Florida Power Corporation referenced this report in the information previously submitted to NRC.

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The Long Term Test has recently been completed by the Carborundum Company. The results of this part of the Test Program are presented in CBO-N-79-064 (Addendum A, March 1979) which has also been submitted as a proprietary report under Dockets 50-218 and 50-245.

The purpose of the Long Term Test Program was to establish the mechanical and physical behavior of the B4C plates and Composite materials for simultaneous exposure up to 10^{11} Rad gamma and deionized water. The mechanical behavior of the material was assessed by determining the Ultimate Tensile Strength (UTS) and the Modulus of Elasticity (MOE) values at various exposure levels during the program. The physical behavior of the material was assessed by visual inspection and by dimensional and weight determinations at various exposure levels. The B^{10} loading was measured by means of destructive chemical analysis on samples exposed to 5×10^{10}, 8×10^{10}, 10^{11} Rad gamma.

Mechanical Properties

The response to NRC Question A6 of Enclosure 2, Request for Additional Information, stated that the Composite material would possess adequate strength if the Ultimate Tensile Strength (UTS) value exceeded the specified value of 2200 psi during and after simultaneous exposure to the design radiation level of 10^{11} Rads and prototypical spent fuel pool water environments. If the Composite material met the specification value of 2200 psi, the actual safety factor considering the bending stresses during a SSE event would be in excess of 40.

The results of the Long Term Test indicate the Composite material exposed to the spent fuel pool water environment will maintain an Ultimate Tensile Strength in excess of 4500 psi for radiation exposures up to 10^{11} Rad gamma. This value is consistent with the predicted value (4500 psi) presented in Table 1 of the response to Question A6 of Enclosure 2. It should be noted that this value (4500 psi) was established for Composite material tested in a moist condition (see Item III, Section IV-ii, Addendum A). Even if the UTS values associated with samples dried for 1 hour at 105°C (for weight determinations) are considered, the minimum value determined for exposure up to 10^{11} Rad was 2757 psi. This value is still greater than the minimum specified value (2200 psi).

The Modulus of elasticity value exhibits essentially no change in value throughout the Long Term Test Program (from 10^{10} to 10^{11} Rad).

Physical Properties

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The results of the Long Term Test Program indicate that the composite material lost mass as the radiation exposure increased from 10^{10} to 10^{11} Rads gamma. It was concluded that the material loss was essentially dose related (less than 2 w/o is attributed to immersion in the deionized water) and primarily a surface phenomenon. Visual and micrographic examination of the Composite test samples (pre- and post-irradiation) indicated that the material was preferentially lost from one side of the Composite material and that the maximum loss rate occurred between 3 and 5.5 x 10^{10} R. gamma (approximately 3 times greater than the rate observed between 8 x 10^{10} and 1 x 10^{11} Rads gamma).

The Composite material consists of three regions: the primary side which contains the major concentration of B4C material, the reinforcing fiber which contains B4C and binder materials in the spaces between the fibers and the back side which contains lesser amounts of B4C and binder material. The B4C and binder material lost from the Composite material came primarily from the back side. It has been concluded that this preferential loss occurs because the B4C concentration in the back side is only 50% of that in the primary side. Essentially, all radiation effects data show that the radiation resistance of the binder material is greatly enhanced by the addition of mineral filler materials such as B4C. The higher concentration of B4C in the primary side protects the associated binder material to a greater degree than the lower B4C concentration in the back side.

This conclusion is supported by the fact that the majority of material lost from the back side occurred during the exposure range from 3 to 5.5 x 10^{10}- Rads gamma and that the composite material exhibited only a modest weight loss, thereafter, from 5.5 x 10^{11} through 10^{10} Rads exposure.

The principal concerns with the loss of mass are, 1) the integrity of the bond between the main coat material and the reinforcing material and 2) the potential effect of the loss of B4C on the k_{eff} value. Bond strength of the irradiated material has been tested to demonstrate the integrity of the main coat/reinforcing material bond. This was done by way of a bend test (samples placed in a vertical mode are arched repeatedly to stress the bond) and a tape test (primary side of samples are attached to standard tape and then the tape is removed: amount of B4C grain adhering in tape measures bond strength). The results of the test verify that an adequate bond has been maintained. No tendency of the main coat to separate from the reinforcing material fibers has been observed.

With respect to the effect on k_{eff} value, the loss of B4C has been determined to reduce the B^{10} concentration by 15%. The Composite material manufactured for Crystal River has an average B^{10} concentration of 0.0150 gm B^{10}/cm^2 as determined by chemical analysis of random samples. Applying the 15% reduction in B^{10} concentration to this value produced a B^{10} concentration of 0.01275 gms. B^{10}/cm^2 which is still greater than the minimum concentration value used to establish the k_{eff} values in the Criticality Analysis (0.012 gm B^{10}/cm^2). Consequently, the worst case abnormal k_{eff} value is expected to remain below the value reported in NES 81A0521 (0.9356). Even if the maximum reduction in B^{10} concentration observed in any single Test Program sample (19.2%) is applied to the minimum B^{10} concentration established for the Crystal River Composite production material (0.0125 gms B^{10}/cm^2), the worst case abnormal k_{eff} value increases from 0.9356 to only 0.9390. Clearly, the k_{eff} value remains significantly below the 0.95 criterion.

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It is, therefore, concluded the Composite material selected for use in the Crystal River high density fuel racks maintains acceptable mechanical and physical properties after simultaneous exposure to gamma radiation levels of 10^{11} Rads and prototypical fuel pool environments.

As a result of Florida Power Corporation's past responses to NRC Questions/Concerns, and along with the additional information provided in this letter, we are confident that all issues can be resolved and we are, therefore, presently preparing for the installation of high density spent fuel storage racks at CR#3. The preparation and installation of these racks will be in 4 phases, as identified in our letter to you dated March 16, 1979 (Enclosure 1, Response 1). The approximate date for the beginning and ending of each Phase is provided below.

Phase	Begin	End
I - Decontamination of Pool A	June	July
II - Rack Removal	Aug. - Sept.	Oct.
III - Rack Disposal	Undetermined at this time.	
IV - Installation of High Density Racks and Clean-up Activities	Nov.	Feb.

In order to meet the above schedule it was necessary for FPC to authorize fabrication of these high density racks prior to receiving NRC approval. This submittal completes our response to your concerns regarding the use of the poison material manufactured by Carborundum Company and we would, therefore, like to discuss any of our submittals your staff deems necessary, in order that NRC approval of our modification can be achieved in a time frame consistent with resolution of the generic licensing issues and the above schedule.

Please contact this office if you, or members of your staff require additional information concerning this subject. It is imperative that this modification be completed prior to the next refueling outage to ensure adequate storage capacity is available for all modes of operation.

Very truly yours,

FLORIDA POWER CORPRATION

G. C. Moore

G. C. Moore
Assistant Vice President
Power Production

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File: 3-0-3-a-3

STATE OF FLORIDA

COUNTY OF PINELLAS

G. C. Moore states that he is the Assistant Vice President, Power Production, of Florida Power Corporation; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission the information attached hereto; and that all such statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

G. C. Moore

Subscribed and sworn to before me, a Notary Public in and for the State and County above named, this 29th day of May, 1979.

Notary Public

Notary Public, State of Florida at Large,
My Commission Expires: July 25, 1980

(CRPNotary 1 D12)