STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Rhode Island Atomic Energy Commission
NUCLEAR SCIENCE CENTER
South Ferry Road
Narragansett, R. I. 02882

September 5, 1979

U. S. Nuclear Regulatory Commission
Division of Operating Reactors
Operating Reactors Branch
Washington, D. C. 20555

POOR ORIGINAL

Gentlemen: Attention: Mr. D. DiIanni

Docket No. 50-193
License R-95

The R. I. Atomic Energy Commission hereby requests that the R. I. Nuclear Science Center reactor license, R-95, Docket 50-193, be amended to permit the use of uranium aluminide (UAlx) or uranium oxide (U_3O_8) fuel elements in addition to the currently licensed uranium-aluminum alloy elements. This amendment is necessary because there is presently no domestic commercial vendor capable of producing alloy type fuel.

Specifically, two license changes are required as follows:

A. Amend page 7, Section E (1) of the technical specifications to read:

1. Principal Core Materials

Fuel matrix	Alloy, UAlx, U_3O_8
U-235 enrichment	Approximately 93%
Fuel clad	1100 and/or 6061 aluminum
Fuel element side plates	6061 aluminum
End Fittings	356 T6 aluminum
Moderator	Water
Reflector	AGOT grade graphite and/ or water
Control elements	Mixture of B_4C and aluminum, clad with aluminum
Servo element	Mixture of B_4C and aluminum, clad with aluminum

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B. On page 29 of the technical specifications, add a new section (f) to K.3.e.(4) to read:

(f) Fission Density Limit

The fission density limit for alloy, uraninum aluminide, and uranium oxide fuel shall meet the following specifications:

1. The fission density limit shall be 1.5×10^{21} fissions/cc.

2. The fission density of all fuel elements which have burnup shall be calculated at least quarterly.

The first amendment will permit the use of UAlx and U_3O_8 fuel in addition to alloy type fuel. It will also permit the use of 6061 aluminum as clad in addition to 1100 aluminum.

The second amendment will add to the technical specifications a fission density limit along with a minimum frequency for calculating the fission density.

The UAlx and U_3O_8 fuels have been satisfactorily used in operating environments similar to those in the R. I. Nuclear Science Center reactor. Table 1 presents operating characteristics for six reactors which have used these fuels. The operating characteristics for the R. I. reactor are included for comparison.

In June 1977, the Ford Nuclear Reactor at the University of Michigan submitted a safety analysis[1] for use in its reactor of UAlx and U_3O_8 in addition to alloy fuel. Their submission was revised on 10/26/77 and 4/20/78. A NRC safety evaluation[2] was issued and in October 1978, NRC approval for the use of UAlx and U_3O_8 fuel in the Michigan reactor was granted.

UM's amendment request and the R. I. amendment request are essentially the same. However, the two reactors differ in the following respects.

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[1]Utilization of Intermetallic Uranium Aluminide (UAl_3, UAl_4, UAl_2) and Uranium Oxide (U_3O_8) Cermet Fuel Cores in the Ford Nuclear Reactor, License R-28, Docket 50-2, U. of Michigan, June 1977.

[2]Safety Evaluation by the Office of Nuclear Reactor Regulation Supporting Amendment No. to Facility Operating License, University of Michigan, Ford Nuclear Reactor, License No. R-28.

TABLE 1

TRAINING, RESEARCH, AND TEST REACTOR OPERATING PARAMETERS

Parameter	Materials Testing Reactor (MTR)	Engineering Test Reactor (ETR)	Advance Test Reactor (ATR)	High Flux Isotope Reactor (HFIR)	High Flux Brookhaven Reactor (HFBR)	Ford Nuclear Reactor (FNR)	R. I. Nuclear Science Center
Year placed in service	1952	1956	1967	1965	1965	1958	1964
Plate geometry	curved	flat	curved	involute	flat	curved	flat
Thermal power (MW)	40	175	40	100	40	2	2
Thermal power density (MW/l)	0.75	1.2	2.8	1.5	0.5	.025	.02
Fuel element meat volume (cc)	365	550	798	3475	870	358	182.63
U-235 per element (gm)	200	400	975	2600	315	140	124
U-235 burnup (%)	-	25	25	30.6	34	35	15.3
Peak fission density (fiss/cc)	-	1.8×10^{21}	1.8×10^{21}	1.9×10^{21}	1.24×10^{21}	1.5×10^{21}	1.5×10^{21}
Fuel element surface area (ft^2)	15	23	34	147	36	15	12.9
Heat flux (BTU/ft^2-hr)	3.5×10^5	5×10^5	4×10^5	2.5×10^6	3.8×10^5	4×10^4	2.59×10^4 (1)
Fuel surface temperature (°F)	239	329	356	300	304	159	150 (2)
Coolant flow rate (gpm)	24,000	44,000	16,000	17,000	16,600	980	1,500
Fuel element materials:							
Cladding	1100 Al	1100 Al	6061 Al	6061 Al	6061 Al	1100 or 6061 Al	1100 or 6061 Al
Core (wt% Uranium)	18% U-Al Alloy & UAl_x	22% U-Al Alloy & UAl_x	41% UAl_x	41% U_3O_8	30% U_3O_8	14% U-Al Alloy	26%

(1) 28 element core
(2) excludes hot spot factors

1. The R. I. element contains only 124 grams of U-235 as opposed to 140 grams for Michigan. This results in a larger core, lower power density, smaller percent burnup and lower fuel element surface temperatures for the R. I. reactor.

2. The R. I. fuel plate is flat as opposed to a curved Michigan plate. As discussed in the Michigan submission (page 4, paragraph 5.1) and the NRC safety evaluation for Michigan (page 2, Fuel core swelling) some warping caused by swelling was observed in flat plate samples irradiated to the 7% $\Delta V/V$ swelling level. However, for a fission density limit of 1.5×10^{21} fissions/cc, a 7% change in volume does not occur. Moreover, for a given fission density limit, swelling in alloy fuels is greater than in other types. Since flat plate alloy fiel has been used for many years in the R. I. reactor without noticeable warping due to swelling, flat plate aluminide and oxide fuel will also prove satisfactory.

3. The fueled core of the R. I. fuel plate is .012 inches as opposed to .02 inches for the Michigan element. This will result in a higher weight percent uranium in the R. I. element. However, as seen from Table 1, the 26 weight percent of the R. I. element is well below what has been utilized in other reactors.

4. The clad of the R. I. element is .024 inches thick as compared to .02 inches for the Michigan element. This minor difference is of no physical significance in evaluating a change from alloy to aluminide or oxide fuel in the R. I. element. No dimensional changes will be made in the R. I. fuel element.

5. The weight percent of uranium in the fuel core of the R. I. element is 26% as compared to 14% for the Michigan element. However, as shown in Table 1, the 26% is well within the capability of the technolog for both UAlx and U_3O_8.

The amendment request to permit the use of 1100 and/or 6061 aluminum instead of 1100 aluminum is insignificant because of the similarities of the two materials. In general 6061 is stronger and 1100 has a higher thermal conductivity. However, the lower 6061 thermal conductivity is not significant since in heat transfer from fuel meat to coolant the clad thermal resistance is a negligible percentage of the film resistance at the clad-coolant interface.

The aluminide or oxide fuel elements will dimensionally be exactly the same as the current alloy elements. The thermal and hydrolic

Docket No. 50-193
License R-95

characteristics of the reactor will therefore be unchanged.

We will be pleased to provide more information if necessary.

Very truly yours,

A. Francis DiMeglio
Director

AFD:kc

cc: RIAEC
RUC

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Signed and sworn before me this 7th day of September, 1979.

Alice C. Gillan, Notary Public
My commission expires 6/30/81

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