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SUBJECT: Irradiation Experiment on Aluminum Fuel Plates Containing
a 48 w/o Uranium - 52 w/o Aluminum Alloy, with a 20% En-
richment in the U-235 Isotope

TO: J. E. Cunningham

FROM: R. J. Beaver

Ref: (a) ORNL-MTR-30, AEC 320 Form, dated June 5, 1956.

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INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

To: J. E. Cunningham

Subject: Irradiation Experiment on Aluminum Fuel
Plates Containing a 48 w/o Uranium -
52 w/o Aluminum Alloy, with a 20% En-
richment in the U-235 Isotope

Copies: Listed Distribution

I. Purpose.

In accordance with reference (a) a request was submitted to evaluate the irradiation behavior of aluminum fuel elements, containing an aluminum-uranium alloy, concentrated in uranium at 48 weight percent. The 48 w/o uranium-aluminum alloy is an important material in establishing reliable and economical procedures for manufacturing aluminum MTR-type fuel elements under the Atoms for Peace Plan in which uranium, with a maximum enrichment of 20% in the U-235 isotope, is specified. This enrichment specification necessitates a high total uranium investment in each fuel element. Technology for manufacturing such fuel elements is very limited, especially behavior under actual reactor operating conditions.

II. Design of Test Component.

The test assembly contains 18 plates spaced at 117 mil intervals. Each plate is a composite consisting of 17-26-17 mil clad-core-clad thickness, with a total thickness of 60 mils. Design details of the test component are listed in Table I. Materials data of the fuel core are itemized in Table II. The enrichment factor may vary between 19.5 and 20.0 percent, which will reflect a slight change in the total uranium weight percent.

The cladding material will be a J51S aluminum alloy with nominal composition of 0.6 Mg - 0.35 Si and 0.25 Cu. The frame material will be a 6951 aluminum alloy with a nominal composition of 1.0 Mg - 0.6 Si - 0.25 Cu and 0.25 Cr. These alloys are required to minimize thinning of the cladding at the core ends.

III. Physical and Nuclear Data.

The physical and nuclear data for the test element are listed in Table III. The test component contains approximately 3876 grams of aluminum, 950 grams of uranium, 27 grams of silicon, 17 grams of magnesium, 6 grams of copper and 0.4 grams of chromium, calculated on the basis of a 60 cm. effective length. The

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total absorption cross-section of these materials for thermal (0.025 ev) neutrons is 402.33 cm² and 356.35 cm² with and without water respectively. The test component contains 190 grams of U-235 resulting in a fission cross-section of 280.0 cm². The thermal and fission cross-section values used for these calculations were 680 and 575 barns respectively.

IV. Construction of the Test Component.

The test plates will be fabricated with techniques similar to those used in roll-bonding the conventional MTR fuel plates. The fuel plates will be curved and joined into an assembly by brazing, utilizing current procedures for brazing MTR assemblies. The test assemblies will be identified as ORNL-30-1 and ORNL 30-2, respectively, and will contain markings on the side plates to permit machining of individual plates from the assembly for post irradiation examination.

V. Time of Irradiation.

It is desirable to observe the performance of one element during a 6-week and the other during a 12-week irradiation period. The test elements are designed to be substituted directly into the active lattice and serve as fuel assemblies for the MTR. The exact positions the test elements will occupy during irradiation will be determined by the Phillips Petroleum personnel.

R. J. Beaver

RJB:fw
Attachments, Tables I,II,III.

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Table I

Design Data on Assembly Containing 48 w/o U-Al Alloy for
Irradiation Testing in the MTR

Number of test elements	2
Irradiation time	ORNL-30-1 6 weeks ORNL-30-2 12 weeks
Number of fuel plates per element	18
Nominal water gap spacing, inches	0.117
Width and length of active position of plate, inches	2.5 x 23-5/8
Overall width and length of active plates, inches	(2) 2.8 x 28-5/8 (16) 2.8 x 24-5/8
Total thickness of active plates, inches	0.060
Cladding thickness of active plates, inches	0.017
Core thickness of active plates, inches	0.026
Nominal core composition, w/o	Uranium - 48 Aluminum - 52
U-235 enrichment, w/o	20.00 / 0.00 -0.05
U-235 content per plate, grams	10.56
U-235 content per assembly, grams	190.00
U-235 fuel distribution, gm/cm ²	0.027
Type of MTR assembly	Mark X (modified)
Side plates - ORNL Dwg. D-22055	
Overall dimensions, inches	3.169 x 0.188 x 28-5/8
Grooves, inches	0.070

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Table II

Materials Data of Fuel Core in Fuel Plate
Of Test Assembly

Core volume based on one plate -----1.536 in³ or 25.16 cm³

<u>Material</u>	<u>gms weight</u>	<u>% weight</u>	<u>gm-mole fraction</u>	<u>Atomic %</u>
U total	52.80	48.0	0.22	9.4
U-235	10.56	--	--	
U-238	42.24	--	--	
Aluminum	57.20	52.0	2.12	
Totals	110.00	100.00	2.34	

Table III

Physical and Nuclear Data on Test Assembly
Containing 48 w/o U-Al Alloy

<u>Material</u>	<u>cm² cross-section</u>	<u>cm³ volume (1)</u>	<u>gms mass</u>	<u>cm² absorption (2) cross-section</u>	<u>cm² fission cross-section</u>
U-235			190.08	331.10	280.00
U-238			760.32	5.34	
U-total	1.05	63.00	950.40	--	
Aluminum	23.92	1435.18	3875.78	19.07	
Silicon	0.19	11.51	26.82	0.58	
Magnesium	0.16	9.89	17.20	0.03	
Copper	0.01	0.70	6.29	0.21	
Chromium	0.001	0.06	0.42	0.02	
Water (3)	35.79	2147.40		45.98	
Total Solids or Metals	25.33	1520.34	4876.91		
Metal to Water Volume Ratio --		0.71			
Total Absorption Cross-section				402.33	
Fission Cross-section					280.00

- (1) Based on 60 cm effective length
- (2) Cross-section of 0.025 ev neutrons
- (3) Includes one-half of water spacing between adjacent MTR fuel elements