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PHASE III ABSORBER ROD SAMPLE IRRADIATION
Irradiation Request ORNL-MTR-28

I. Introduction

Phase III of the Absorber Rod Irradiation Program, ORNL-MTR-28, is based upon the results obtained from the examination of the Phase I samples, and upon recent burn-up estimations of the APFR absorber rod. This report will briefly cover the results of Phase I, and outline the testing procedure for Phase III.

Phase I consisted of irradiating miniature APFR control rod samples in the MIR to varying degrees of B_{10} atom burn-up. In all, five samples were irradiated. It was observed that the two samples irradiated to a burn-up greater than 41% failed during testing. The three samples irradiated to a burn-up less than 41% showed an increase in volume corresponding to the degree of irradiation. Since the MIR operating temperature is far below that of the APFR, the three samples with estimated B_{10} atom burn-ups of 11, 32 and 41% were subjected to cyclic-type anneals at 600°F for a total time-at-temperature of 312 hours. At the completion of each 48-hour cycle, the samples were measured for dimensional stability. It was found that both the 32 and 41% samples blistered after about 216 hours at 600°F. These blisters were over the entire core area; however, in neither case was an actual clad rupture observed. The sample which was irradiated to an 11% burn-up of the B_{10} atoms showed no blistering or dimensional changes during the 312-hour anneal at 600°F.

In view of these irradiation results, Phase III has been initiated. As indicated in Table I, this phase will consist of irradiating a total of 18 miniature samples of APFR designed B_{10} loading to a maximum burn-up of 30%. Estimations tend to indicate that the maximum B_{10} burn-up in the absorber rod will be within the irradiation limits of this phase. Upon the completion of the irradiation testing, a sample receiving each specified burn-up will be annealed at the temperatures listed in Table I. These annealing tests should indicate the permissible degree of burn-up as a function of temperature, without causing severe growth or blistering to the absorber plate. The annealing temperatures used in these tests are comparable to the temperature conditions of the absorber rod in the APFR. As in Phase I, each sample will be measured before and after irradiation to determine dimensional stability as a function of irradiation exposure.

II. Design and Fabrication of Miniature Samples

The design and fabrication of the miniature samples are identical to the irradiation samples used in Phase I. A brief description of the procedure appears in ORNL CF-56-6-173*. The absorber plate composition is indicated in Table II.

* Neill, F. H., and Leitten, Jr., C. P., Phase I Absorber Rod Sample Irradiation, ORNL CF-56-6-173, June 27, 1956.

Table I*

TESTING SCHEDULE

<u>Sample Number</u>	<u>Annealing Temp., °F</u>	<u>Required NVT</u>	<u>Estimated B₁₀ Atom Burn-up, Atomic %</u>
3-2	450	1.75×10^{20}	5
3-4	500	1.75×10^{20}	5
3-6	600	1.75×10^{20}	5
3-7	450	3.75×10^{20}	10
3-8	500	3.75×10^{20}	10
3-9	600	3.75×10^{20}	10
3-10	450	5.5×10^{20}	15
3-11	500	5.5×10^{20}	15
3-12	600	5.5×10^{20}	15
3-16	450	7.25×10^{20}	20
3-17	500	7.25×10^{20}	20
3-18	600	7.25×10^{20}	20
3-19	450	9.25×10^{20}	25
3-20	500	9.25×10^{20}	25
3-21	600	9.25×10^{20}	25
3-22	450	11.25×10^{20}	30
3-23	500	11.25×10^{20}	30
3-24	600	11.25×10^{20}	30

* Schaffer, L. D., and Neill, F. H. Minutes of Meeting on Control Rod Irradiation Program. ORNL CF-57-4-29, April 9, 1957.

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Table II

ABSORBER ROD COMPOSITION

1. Core Composition:

3.23 wt.% as-received boron; 100% -100 mesh
90% -200 mesh
96.77 wt.% electrolytic iron; -100 mesh

2. Boron-10 Loading Per Plate:

0.659 grams of as-received boron
0.630 grams of boron
0.585 grams of boron₁₀

The finished overall core and plate dimensions are presented in Table III.

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Table III

FINISHED OVERALL CORE AND PLATE DIMENSIONS

Plate Identification	Maximum Core Width	Nominal Core Length	Overall Plate Width	Overall Plate Length	Overall Plate Thickness	Minimum Edge, Stainless Steel	Minimum End, Stainless Steel
	(Inch)	(Inch)	(Inch)	(Inch)	(Inch)	(Inch)	(Inch)
3 - 2	0.516	4.500	1.000	6.502	0.156	0.234	0.250
3 - 4	0.516	4.500	1.002	6.502	0.156	0.234	0.250
3 - 6	0.516	4.500	1.002	6.504	0.156	0.234	0.281
3 - 7	0.516	4.500	1.001	6.501	0.156	0.234	0.281
3 - 8	0.516	4.500	1.001	6.503	0.161	0.234	0.250
3 - 9	0.516	4.500	1.002	6.503	0.157	0.234	0.343
3 - 10	0.516	4.500	1.002	6.504	0.156	0.234	0.281
3 - 11	0.516	4.500	1.002	6.504	0.157	0.219	0.250
3 - 12	0.516	4.500	1.001	6.502	0.157	0.219	0.250
3 - 16	0.516	4.500	1.003	6.503	0.156	0.234	0.281
3 - 17	0.516	4.500	1.003	6.505	0.155	0.234	0.250
3 - 18	0.516	4.500	1.005	6.503	0.155	0.234	0.250
3 - 19	0.516	4.500	1.001	6.503	0.155	0.234	0.250
3 - 20	0.516	4.500	1.003	6.506	0.155	0.234	0.250
3 - 21	0.516	4.500	1.002	6.504	0.158	0.234	0.250
3 - 22	0.516	4.500	1.002	6.505	0.155	0.234	0.250
3 - 23	0.516	4.500	1.002	6.505	0.158	0.234	0.250
3 - 24	0.516	4.500	1.003	6.505	0.155	0.234	0.250

The nominal core-clad thicknesses are 0.090 and 0.033 inch, respectively.

All overall dimensions are maximum values.