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THERMAL UTILIZATIONS OF .600" DIAMETER, 1% URANIUM ROD LATTICES

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May 24, 1956

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Introduction: Earlier reports have mentioned a systematic error in thermal utilization measurements which we have made in the past in slightly enriched uranium, water moderated lattices. This error existed because the material used to locate the flux-detecting foils in the water was chosen to be aluminum, and we have found that the aluminum depresses the flux by an unacceptable amount.

The early measurements are now being repeated, so that correct values for this parameter may be found. We are reporting here the results of such reruns made with 1% enriched, 0.600" diameter rods.

Experimental Methods: The methods used are described in an earlier report on measurements with 0.387" diameter, 1.15% enriched rods (BNL-2754). We have only deviated from the practices given there when the larger rod size used for these later measurements made it necessary to do so; in particular, the lattice cells were larger when 0.600" rods were used, and more foils per lattice cell could be loaded.

All of the measurements reported here were done with miniature lattices of rods, 18" high and about a foot in diameter.

Analysis and Results: The same methods used to analyze the measurements were used in this report and in that mentioned above. The observed flux in the fuel rod was fitted by least squares methods to the parabola

$$\phi = A (1 + a r^2) \qquad (1)$$

The flux curves in the water were drawn by eye. Flux averages in the uranium were found from analytical integration of (1). Flux averages in the aluminum fuel rod cladding and in the water were obtained respectively by inspection and numerical integration of the curves. The thermal utilization was then obtained from these flux averages and the definition

$$f = \frac{\Sigma_a^u \bar{\phi}_u}{\Sigma_a^u \bar{\phi}_u + \Sigma_a^{al} \bar{\phi}_{al} + \Sigma_a^w \bar{\phi}_w} \qquad (2)$$

The cross-sections used in (2) were those listed in BNL-325, averaged over a Maxwell distribution. The atom density of uranium was found from a measurement of the specific gravity (18.90 ± 0.02). The constants used were

	atom density (cm^{-3})	$\sigma_a(cm^2)$	$\Sigma_a(cm^{-1})$
hydrogen	6.69×10^{22}	0.293×10^{-24}	1.957×10^{-2}
aluminum	6.03×10^{22}	0.204×10^{-24}	1.230×10^{-2}
U^{235}	4.971×10^{20}	5.975×10^{-22}	2.970×10^{-1}
U^{238}	4.732×10^{22}	2.438×10^{-24}	1.154×10^{-1}
Total Uranium	-	-	4.124×10^{-1}

The results of the analysis (values of f) are given in table VII and in figure 6. For comparison, table VII also lists the old and incorrect values of f, obtained when aluminum foil holders were used. One can readily see the effect of the higher flux rise in the water which is now observed.

We wish to thank Joyce Meyer for her able assistance with the analysis.

Table I

Relative Fluxes, 1:1 Lattice

Inches from Rod Center	ϕ
0.000	1.008
0.083	1.018
0.166	1.054
0.249	1.143
0.376	1.411
0.448	1.481
0.521	1.476
0.592	1.424
0.665	1.432
0.737	1.435
0.385	1.415
0.466	1.389

Table II

Relative Fluxes, 1.5:1 Lattice

Inches from Rod Center	Ø
0.000	1.014
0.083	1.019
0.166	1.066
0.249	1.167
0.373	1.461
0.446	1.536
0.519	1.600
0.593	1.530
0.665	1.533
0.739	1.512
0.812	1.470
0.366	1.446
0.434	1.501
0.500	1.536
0.567	1.407

Table III

Relative Fluxes, 2:1 Lattice

Inches from Rod Center	∅
0.000	0.994
0.083	1.022
0.166	1.062
0.249	1.154
0.377	1.407
0.450	1.575
0.523	1.608
0.596	1.592
0.669	1.605
0.742	1.590
0.816	1.527
0.887	1.526
0.374	1.379
0.443	1.581
0.512	1.573
0.581	1.529
0.650	1.383

Table IV

Relative Fluxes, 3:1 Lattice

Inches from Rod Center	ø
0.000	0.998
0.083	1.021
0.166	1.080
0.249	1.160
0.383	1.457
0.463	1.621
0.541	1.695
0.621	1.741
0.699	1.757
0.779	1.728
0.858	1.727
0.937	1.733
1.015	1.689
0.386	1.446
0.466	1.633
0.546	1.676
0.627	1.723
0.708	1.626
0.788	1.476

Table V

Relative Fluxes, 4:1 Lattice

Inches from Rod Center	ø
0.000	1.020
0.083	1.016
0.166	1.071
0.249	1.171
0.387	1.509
0.470	1.682
0.553	1.763
0.636	1.841
0.719	1.858
0.802	1.822
0.885	1.839
0.967	1.859
1.050	1.833
1.133	1.821
0.391	1.508
0.478	1.651
0.565	1.755
0.652	1.815
0.739	1.748
0.826	1.708
0.913	1.493

Table VI

Average Fluxes in Fuel, Aluminum, and Water

$\frac{\text{Volume Water}}{\text{Volume Uranium}}$	$\bar{\phi}_u$	$\bar{\phi}_{al}$	$\bar{\phi}_w$
1	1.103	1.220	1.410
1.5	1.119	1.243	1.478
2	1.111	1.230	1.506
3	1.115	1.230	1.614
4	1.123	1.252	1.706

Table VII

Thermal Utilization

$\frac{\text{Volume Water}}{\text{Volume Uranium}}$	f (new value)	f (old, incorrect value)
1	0.937	0.941
1.5	0.909	0.913
2	0.881	0.886
3	0.825	0.833
4	0.773	0.781

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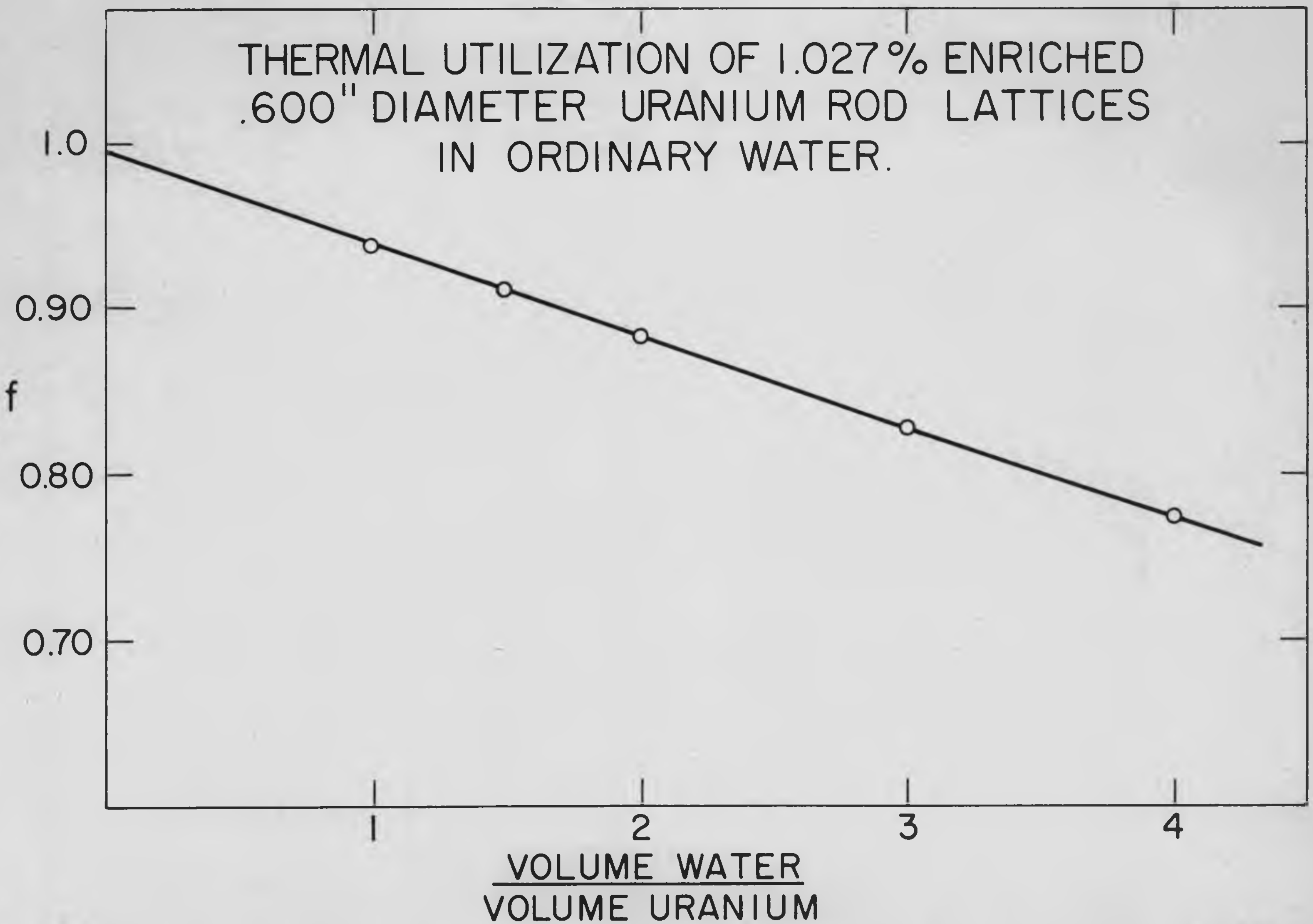

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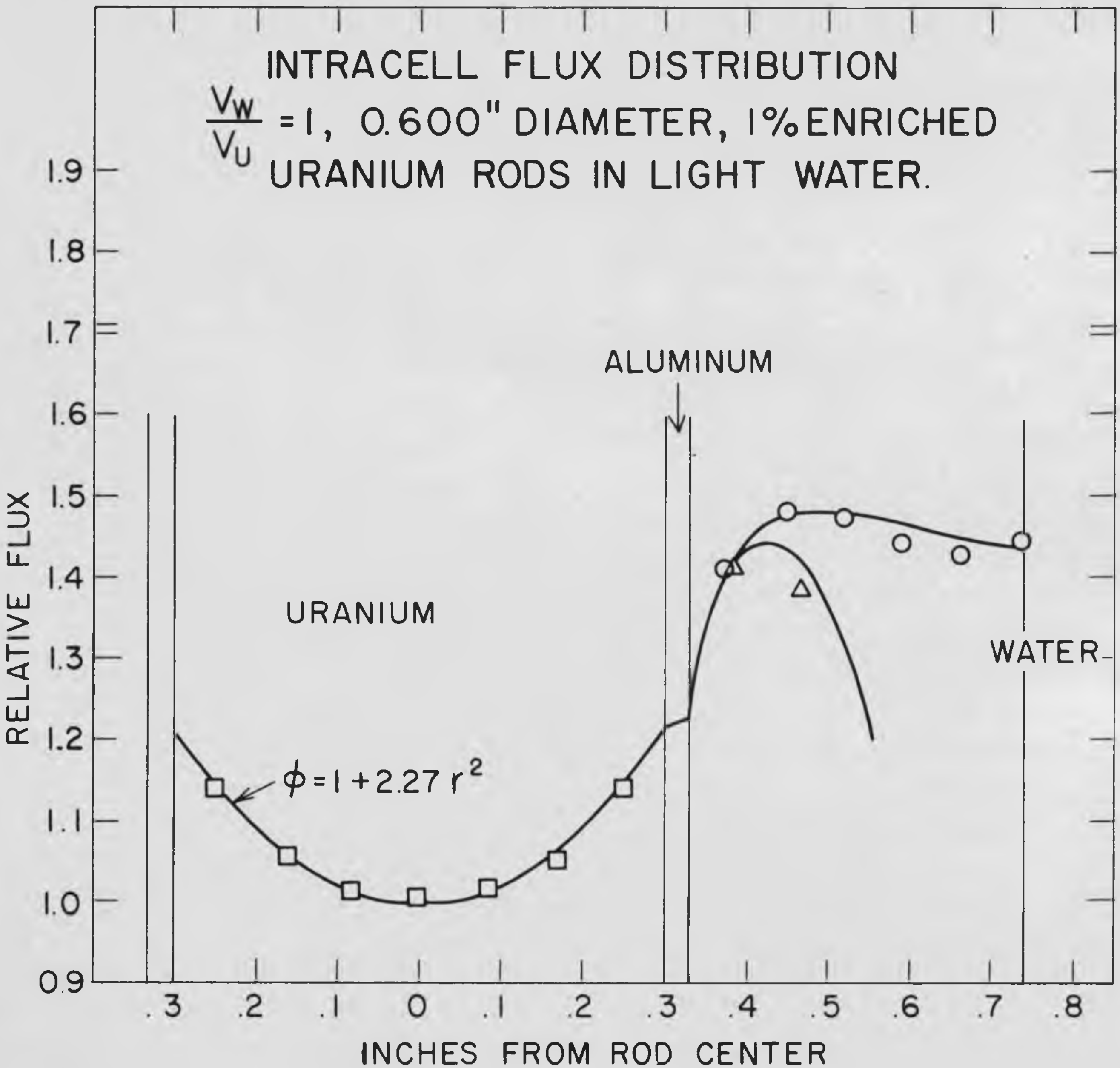

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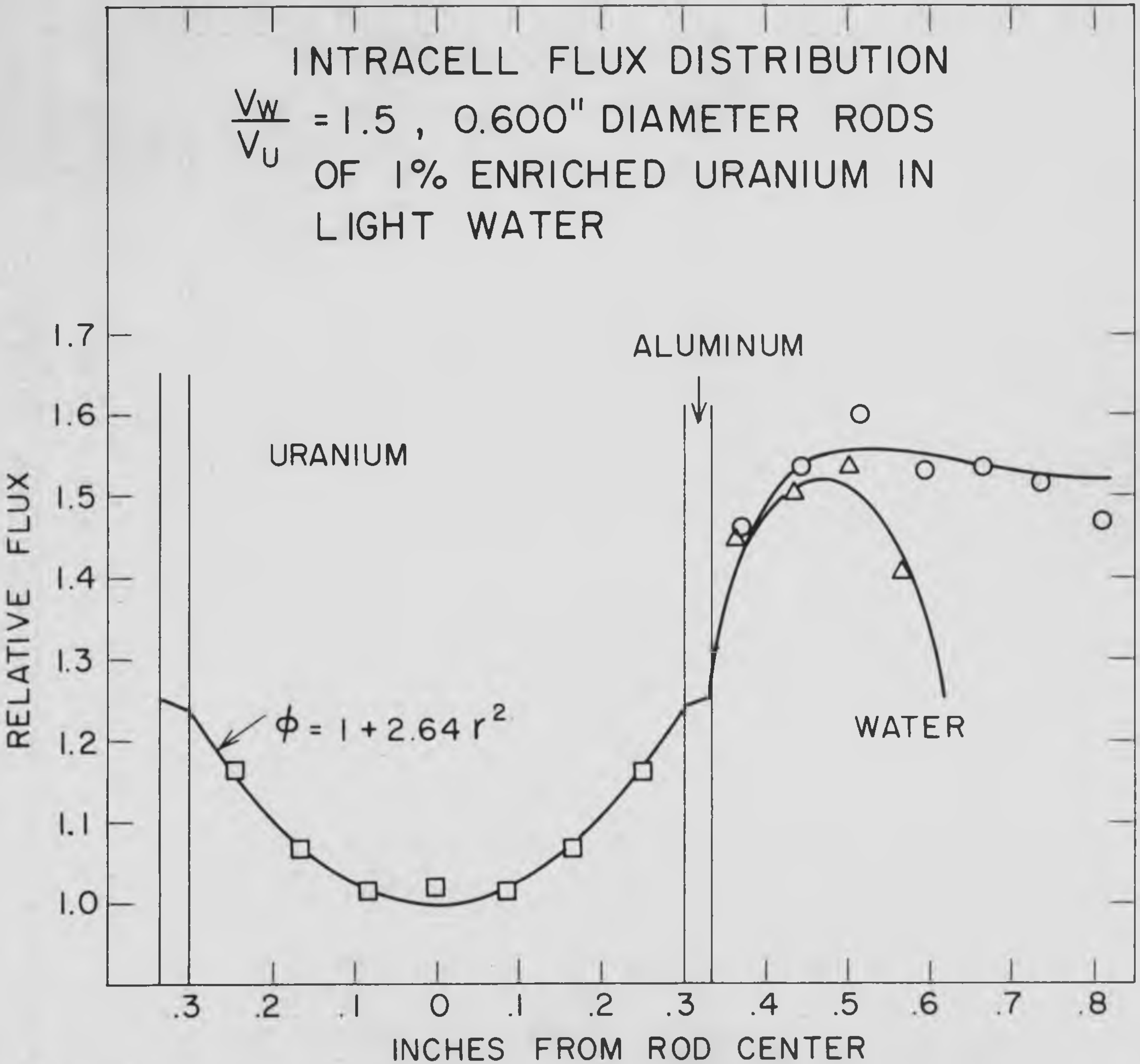

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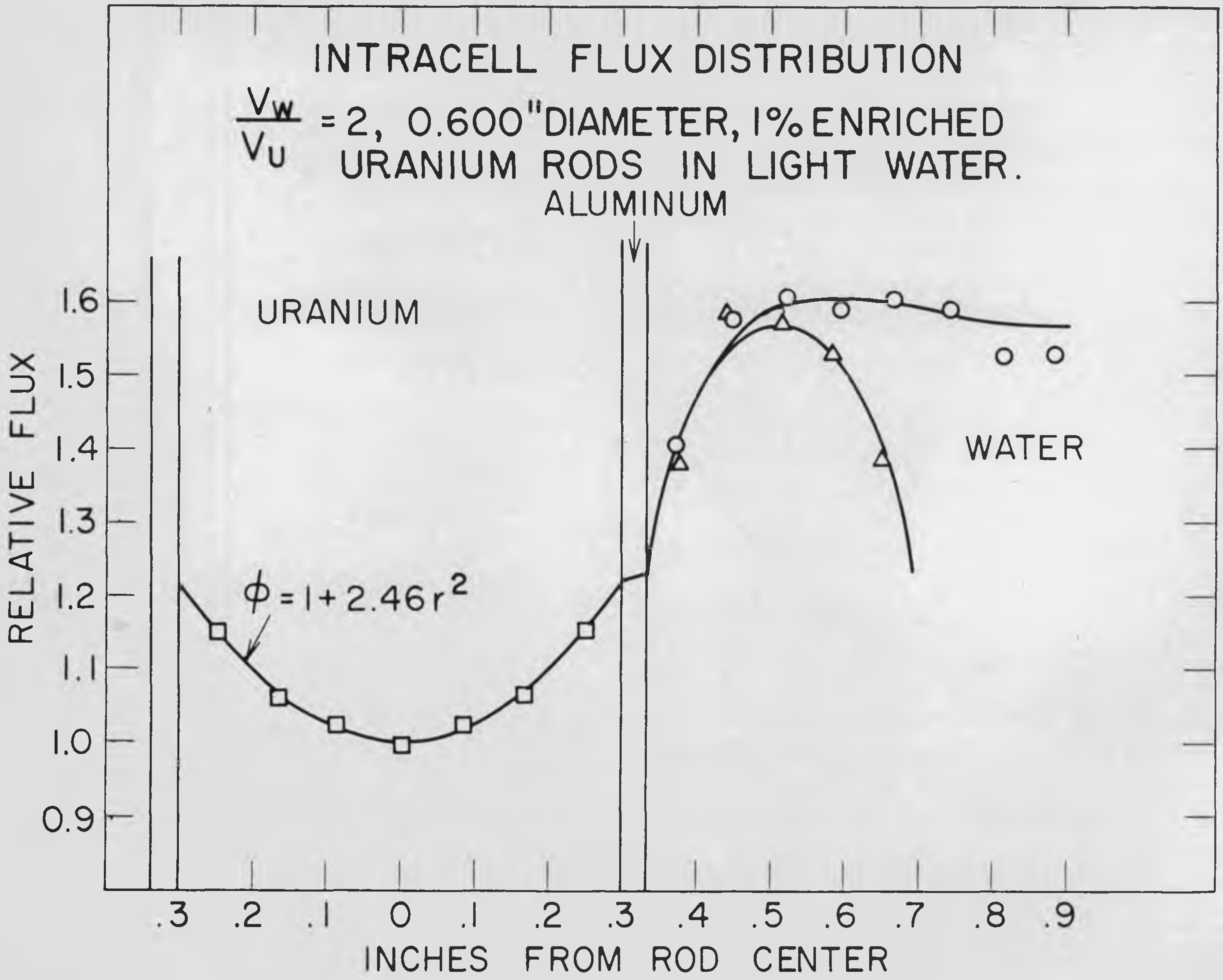

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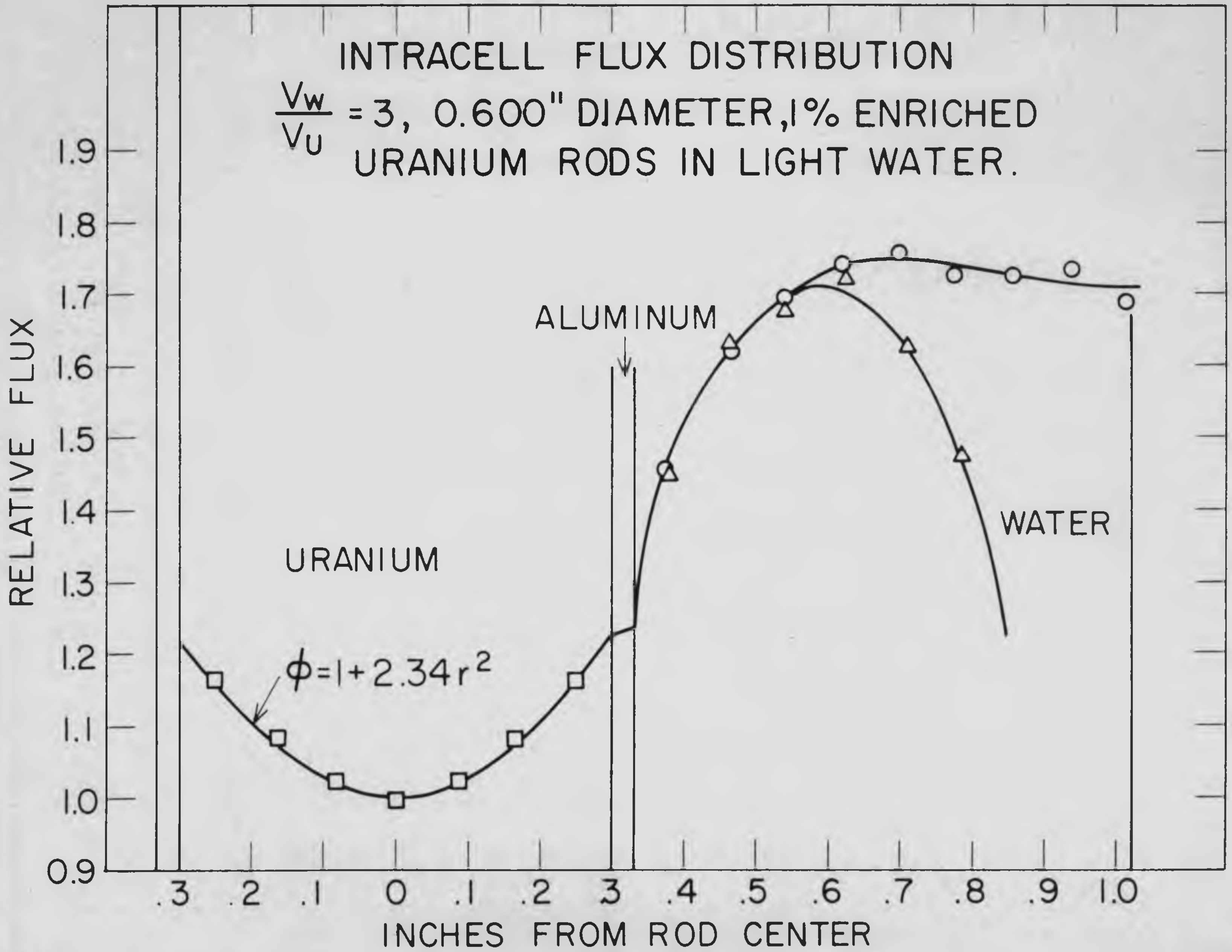

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