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Date: April 18, 1951

Subject: Centerline Foil Measurements of Thermal Neutron Intensities for Experiment 1

To: J. L. Meem

From: E. B. Johnson, G. McCammon, M. P. Haydon

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The attenuation of thermal neutrons from the BSF reactor, described in ORNL-991, has been measured in water along the north-south centerline. The reactor was loaded as in fuel assembly arrangement #2, described in the ANP Quarterly Report, February, 1951. Indium foils were exposed at various distances from the north face of the reactor. The resulting data has been normalized to a power level of 1 watt.

Indium foils 25 cm^2 in area and 5 mil thick were exposed in both aluminum and 30 mil cadmium covers. The maximum weight variation was 4.6%. The resulting activities were measured on two counters, one a thin-walled glass G. M. tube, the other a mica window tube whose counting rate had been normalized to the G. M. tube. In order to eliminate the current component of the flux both sides of every foil were counted and the saturated activities averaged.

Since a maximum of 5 foils could be exposed in one run, it was necessary to do a series of runs to obtain the entire curve. Each of these runs was corrected for "startup" by the equation derived by Dr. E. C. Campbell, of the ORNL Physics Division,

$$\frac{A_o}{A_1 + A_o} = \frac{\frac{1}{\lambda + \mathcal{R}}\left(e^{\mathcal{R}t_o} - e^{-\lambda t_o}\right)e^{-\lambda(t_1 - t_o)}}{\frac{e^{\mathcal{R}t_o}}{\lambda}\left[1 - e^{-\lambda(t_1 - t_o)}\right] + \frac{1}{\lambda + \mathcal{R}}\left(e^{\mathcal{R}t_o} - e^{-\lambda t_o}\right)e^{-\lambda(t_1 - t_o)}}$$

where A_o = activity induced during startup

A_1 = activity induced during level time

λ = decay constant of the detector

$\mathcal{R}$ = 1/pile period

t_o = startup time (time of changing flux)

$t_1 - t_o$ = exposure time (level time)

All runs were normalized together by means of 1 cm^2 gold foils placed on the fuel assembly in position 5 for runs at 0.74 watts and 74 watts, and by means of duplicate positions of the indium foils in the water at the higher power levels. The activity of the foils exposed in 30 mil cadmium covers was corrected by 14% for resonance absorption in the cadmium.

Since cadmium-covered measurements were not made at every position at which a bare foil was exposed, the following procedure was used to obtain flux values. The saturated activities of the bare and cadmium-covered foils and, where possible, the thermal saturated activities, were plotted as a function of distance from the reactor (Fig. 1). From the resulting A_{sth} curve, values were taken at 10 cm. intervals (Table I) and nv_{th} computed on the basis of calibration of these foils in the standard graphite pile. (See CP-2804 for flux values used for the standard pile). Because the calibration of the foils was done in a graphite pile and the exposures in water, it was necessary to increase the flux values by 22%. The basis of this correction is given in a memorandum (C.F. 51-4-103) from Ritchie to Meem.

The shape of the curve in Figure 2 was obtained from nv_{th} values calculated by the above method. The points shown on the curve represent thermal flux values for which A_{sth} was obtained by actual exposures of both bare and cadmium-covered at the indicated positions.

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Table I

CENTERLINE FOIL DATA - EXPERIMENT 1

z	A_s Total	A_s Epicadmium	A_s Thermal	nv_{th}	$\frac{nv_{th}}{watt}$	Cd Ratio
0	1.007×10^{6}	1.958×10^{5}	8.112×10^{5}	7.301×10^{6}	1.205×10^{7}	5.14
7.62	3.286×10^{7}	2.666×10^{6}	3.019×10^{7}	4.227×10^{6}	6.979×10^{6}	12.3
8.454		2.100×10^{6}				
10.00*			1.85×10^{7}	2.59×10^{6}	4.275×10^{6}	
17.70	4.265×10^{6}	2.758×10^{5}	3.989×10^{6}	5.585×10^{5}	9.221×10^{5}	15.5
20.00*			2.45×10^{6}	3.43×10^{5}	5.66×10^{5}	
27.74	5.786×10^{5}	3.835×10^{4}	5.402×10^{5}	7.563×10^{4}	1.248×10^{5}	15.1
28.57	5.329×10^{5}					
30.0*			3.48×10^{5}	4.87×10^{4}	8.04×10^{4}	
37.74	9.609×10^{4}					
38.57	8.799×10^{4}					
40.0*			5.60×10^{4}	7.84×10^{3}	1.29×10^{4}	
47.74	1.784×10^{4}	1.795×10^{3}	1.604×10^{3}	2.246×10^{3}	3.709×10^{3}	9.93
48.57	1.684×10^{4}					
50.0*			1.15×10^{4}	1.61×10^{3}	2.65×10^{3}	
57.82	4.101×10^{3}					
60.0*			2.72×10^{3}	3.81×10^{2}	6.28×10^{2}	
67.86	1.058×10^{3}					
67.90	9.910×10^{2}					
70.0*			6.80×10^{2}	9.52×10^{1}	1.57×10^{2}	
77.94	2.554×10^{2}					
80.0*			1.77×10^{2}	2.48×10^{1}	4.09×10^{1}	
87.94	7.123×10^{1}					

Continued

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Table I (Continued)

CENTERLINE FOIL DATA - EXPERIMENT 1

Z	A_s Total	A_s Epicadmium	A_s Thermal	nvth	$\frac{nvth}{watt}$	Cd Ratio
90.0*			4.90×10^{1}	6.86	1.13×10^{1}	
97.94	1.943×10^{1}					
98.02	2.086×10^{1}	1.467	1.939×10^{1}	2.715	4.482	14.0
100.0*			1.45×10^{1}	2.03	3.35	
108.06	6.17					
108.10	6.273					
110.0*			4.58	6.41×10^{-1}	1.06	
118.06	2.13					
118.14	2.026	1.603×10^{-1}	1.866	2.61×10^{-1}	4.31×10^{-1}	12.6
120.0*			1.50	2.10×10^{-1}	3.47×10^{-1}	
128.06	6.35×10^{-1}					
128.14	6.49×10^{-1}					
128.22	6.61×10^{-1}					
130.0*			4.80×10^{-1}	6.72×10^{-2}	1.11×10^{-1}	
138.14	2.26×10^{-1}					
138.26	2.23×10^{-1}					
140.0*			1.64×10^{-1}	2.30×10^{-2}	3.80×10^{-2}	
148.26	7.70×10^{-2}					
150.0*			6.4×10^{-2}	8.96×10^{-3}	1.47×10^{-2}	
158.26	3.56×10^{-2}					
160.0*			3.1×10^{-2}	4.34×10^{-3}	7.16×10^{-3}	

* $A_{s_{th}}$ obtained from curve in Figure 1.

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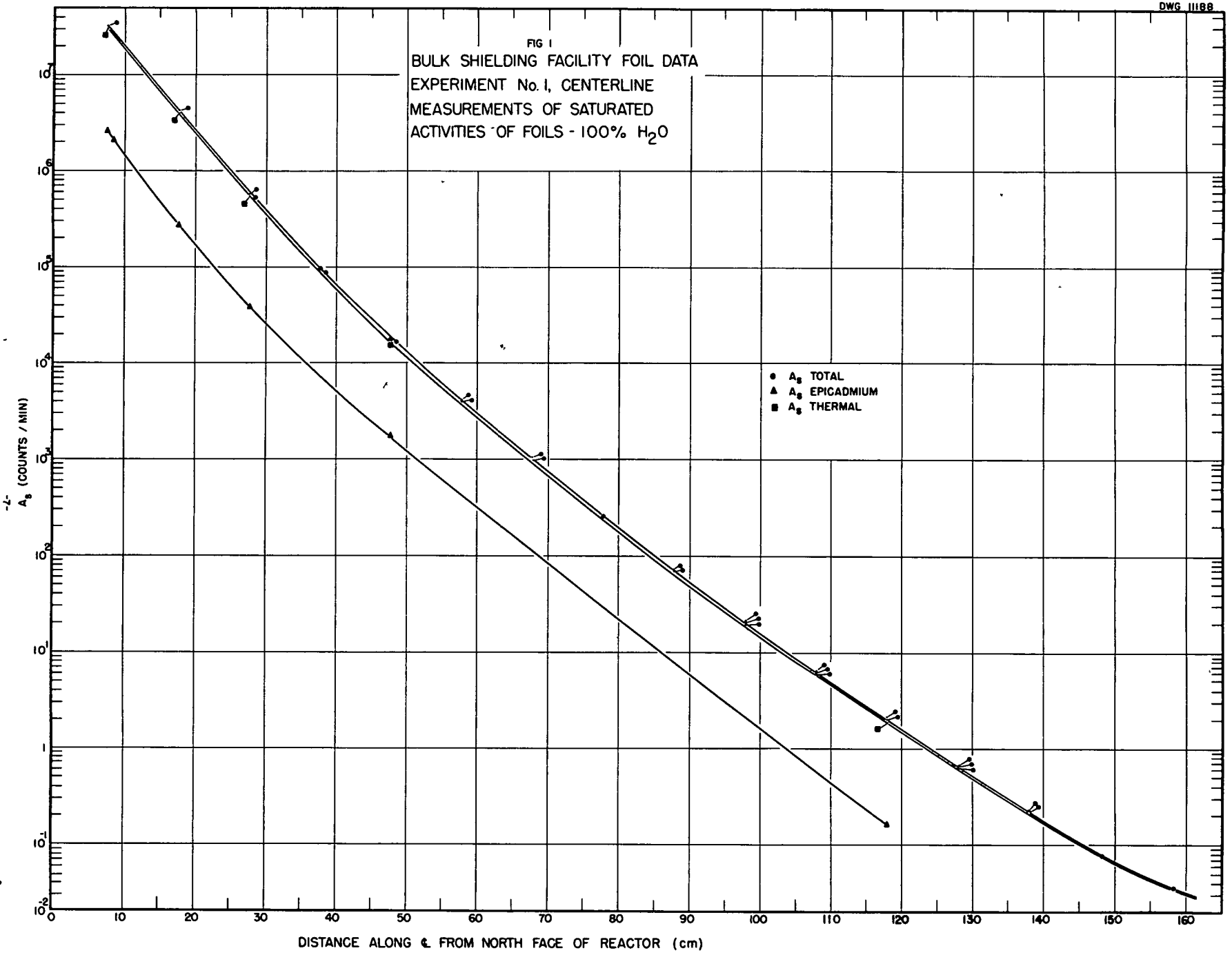

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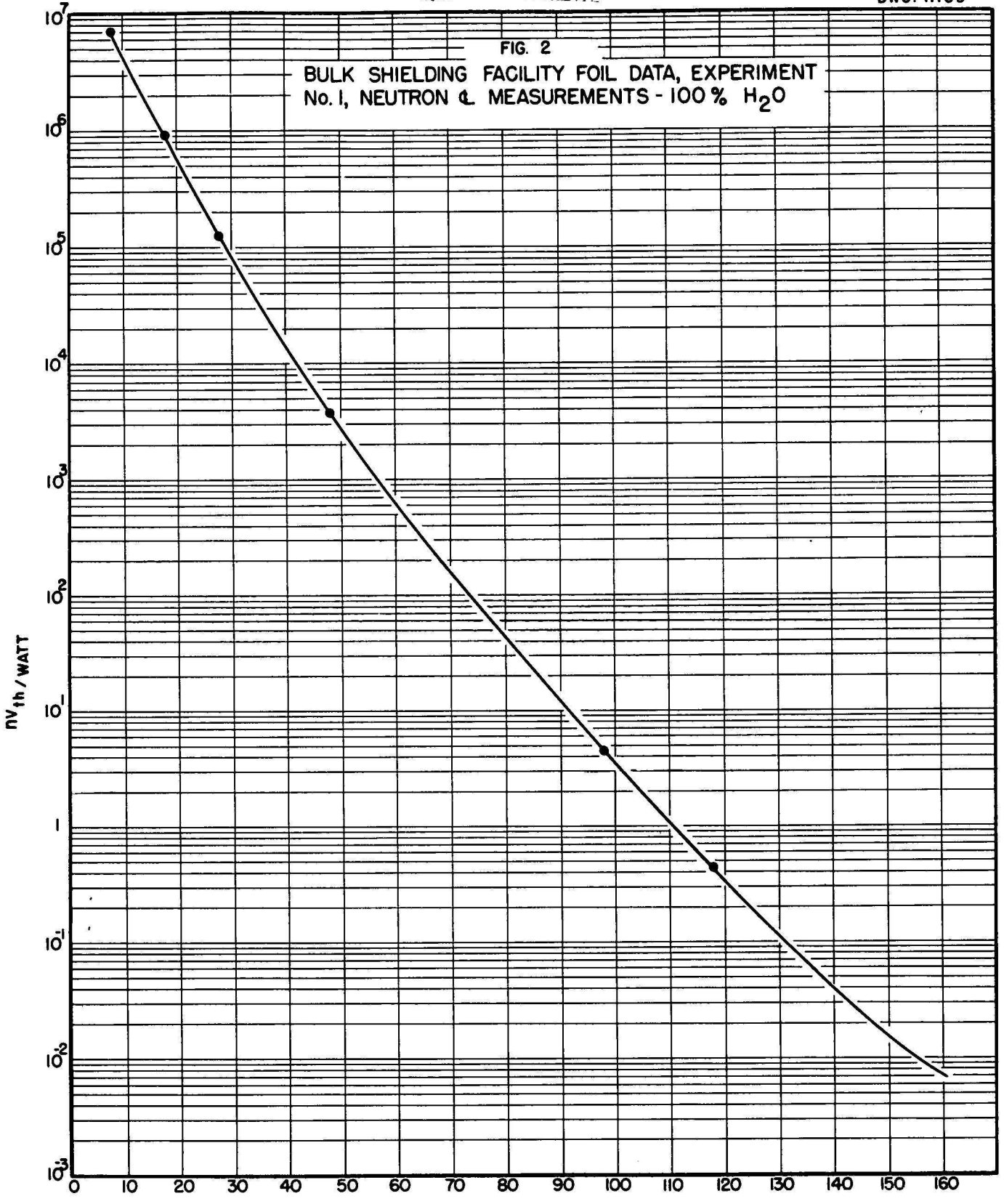
FIG. 2

BULK SHIELDING FACILITY FOIL DATA, EXPERIMENT No. 1, NEUTRON ℄ MEASUREMENTS - 100 % H_2O



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