REFERENCE 188

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1965 WINTER MEETING
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TRANSACTIONS

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3. Neutronic Isolation Characteristics of Concrete, Lead, Wood, Polyethylene and Beryllium / *Thomas G. McCreless (USAEC), David R. Smith, George A. Jarvis (LASL), Dick Duffey (U of Md.)*

Critical-approach experiments have been conducted to determine the neutron isolating effectiveness of concrete, lead, wood, polyethylene and beryllium. The first three are widely used in the construction of storage vaults and shipping containers. Polyethylene has moderating features similar to water but has the advantage of a solid form to facilitate handling. Beryllium, which is a well-known reactor moderating material with excellent reflective characteristics, may provide a basis for comparison with neutron physics measurements.

The Los Alamos Comet assembly machine was used to determine the change in critical thickness of a reference slab of enriched (93.2 wt% U-235) uranium with and without an additional enriched-uranium slab beyond an isolator 8-in. thick. This change in critical thickness is a measure of the neutron interaction between the uranium units. The lesser the effective neutron interaction, the better the isolator.

The critical thickness of enriched-uranium slabs as reflected on one side by different thicknesses of each of the isolating materials is shown in Fig. 1.

TABLE I

Measured Interaction Effects for Values of Fraction of Critical Slab Thickness (F)

Isolator	T_M[a] (in.)	R.S.[b] (in.)	F $\frac{T_M + R.S.}{T_{UC}}$[c]	Interaction Effect (in.)
Concrete	0.945	1.011	0.695	0.059
	1.063	1.011	0.737	0.070
Lead	0.827	0.867	0.602	0.018
	0.945	0.867	0.644	0.030
	1.063	0.867	0.686	0.041
Wood	0.945	0.847	0.637	0.099
	1.063	0.847	0.679	0.116
Polyethylene	0.945	0.927	0.666	0.001
Beryllium	0.472	1.490	0.697	0.051
	0.709	1.490	0.782	0.072
	0.945	1.490	0.866	0.089
Air	0.945	0.276	0.434	0.124
	1.417	0.276	0.602	0.182
	1.535	0.276	0.644	0.193
	1.654	0.276	0.686	0.216
	1.772	0.276	0.728	0.244
	1.890	0.276	0.770	0.287

[a] T_M = measured thickness of additional uranium slab placed beyond isolator.
[b] R.S. = reflector saving as provided by the isolator to the additional uranium slab.
[c] T_{UC} = critical thickness of unreflected enriched-uranium slab (2.813-in.)

The reflector saving is used to determine the fraction of critical slab thickness, F, of the additional uranium slab placed beyond the isolator. These values and the measured interaction effects are given in Table I. The difference between the interaction effects of the isolating material 8-in. thick and of an 8-in. air space, both with the same value of F, is defined as the isolator saving. The ratio of this saving to the interaction effect of air, expressed as a percentage, is the relative isolating ability of the material. For F = 0.675, the relative isolating abilities are: polyethylene, 99.6%; lead, 82%; beryllium, 79%; concrete, 74%; and wood, 45%.

While these percentages are not constant for all values of F, the general trend remains unchanged. For example, For F = 0.7, the relative isolating abilities are: lead, 80.4%; beryllium, 76.8%; and concrete, 72.8%.

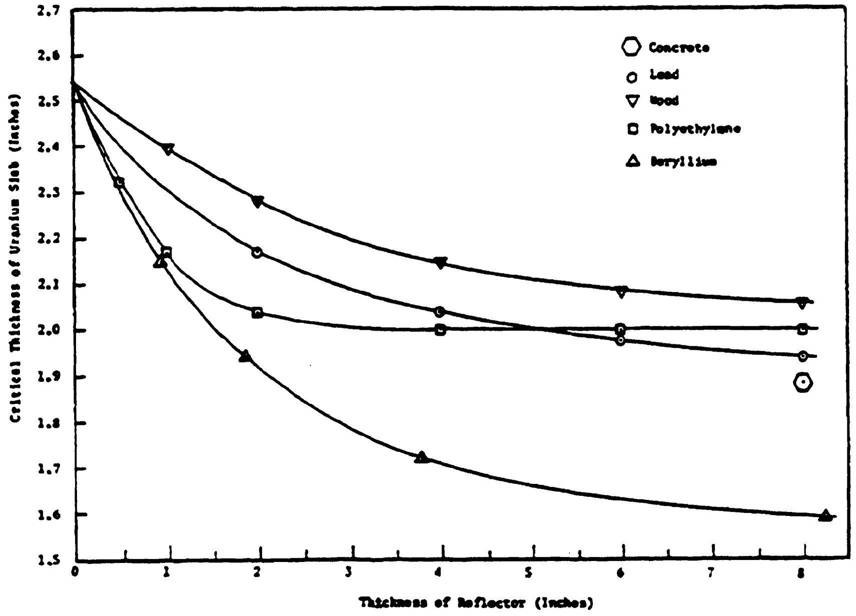

Fig. 1. Composite Plot of Critical Thickness of Uranium Slabs vs Thickness of Reflectors.