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2. Critical and Near-Critical Graphite-Moderated Arrays of U(93.2) Cylinders, *E. C. Crume, J. T. Thomas (UCC-ND)*

A series of experiments and complementary calculations using the KENO program[1] on both bare and thick-polyethylene-reflected, graphite-moderated cubic arrays of 8 nominally 15.7 kg U(93.2) metal cylinders, has been started. Data from these experiments supplement that on unmoderated and hydrogenously moderated arrays of the same metal cylinders,[2] and so will be valuable in the analysis of the effects of array moderation and reflection. Also, the data provide valuable check points for validation of calculational techniques, such as the KENO program, that are used in nuclear criticality safety analysis. This summary presents data and calculational results on the first several experiments in the series.

The arrays consisted of eight units arranged in a cubic lattice. Each unit was constructed of a two-piece graphite block containing a central cavity in which a uranium cylinder was placed. The average diameter, height and mass of the cylinders are 11.494 cm, 8.077 cm, and 15.692 kg, respectively. The Speer Carbon Company Type-873S graphite blocks (ρ = 1.766 g/cm^3) were stacked in contact with one another on top of a low-density aluminum framework to construct the unreflected arrays. The axes of the uranium cylinders were parallel. In the reflected arrays, pieces of square aluminum tubing were used to separate the blocks from one another and from the 6-in.-thick polyethylene (ρ = 0.925 g/cm^3) reflector. The inside surface of the reflector was displaced from the surface of the uranium cylinders one-half the surface-to-surface spacing of the cylinders themselves. Pertinent dimensions of the arrays and their respective experimentally determined criticality conditions are given in Table I.

The KENO calculations were done using Hansen-Roach 16-energy-group neutron interaction cross sections.[3] The calculated k_{eff} and associated statistical 95% confidence interval bounds of each array are also given in Table I.

Preliminary KENO calculations of unreflected arrays indicated that arrays with uranium surface-to-surface spacings from about 7 cm to > 25 cm should be slightly subcritical. Below 7 cm it is necessary to have the thickness of the graphite moderator less than the just-critical surface-to-surface spacing of the uranium. Further calculations indicate the possibility of constructing critical unreflected arrays of this type at spacings of the order of 50 cm. The experimental data reported here confirm the existence of a broad range of slightly subcritical spacings for unreflected arrays, although the limits have not yet been defined. The excellent agreement of the KENO calculations using Hansen-Roach cross sections with the experimental results for these arrays is consistent with the excellent agreement with other experimental assemblies found previously.[4,6]

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TABLE I

Experimental and Calculated Array Criticality Conditions

Surface-to-Surface Spacing (cm)					
U Cylinders[a]		Graphite Blocks	Array U Density (g/cm^3)	k_{eff}	
Side	End			Experimental[b]	Calculated
25.59	22.91	--	0.368	0.996 ± 0.001	0.997 ± 0.005
20.52	17.82	--	0.591	0.993 ± 0.001	0.993 ± 0.010
15.42	12.78	--	1.038	0.990 ± 0.001	0.994 ± 0.010
24.64	21.95	4.128[c]	0.400	0.9995 ± 0.0004	1.006 ± 0.010
19.55	16.91	4.128[c]	0.652	0.9995 ± 0.0004	1.002 ± 0.010

[a]Errors on surface separations are ± 0.02 cm for the unreflected arrays and 0.03 cm for the reflected arrays.

[b]Based on assumed β = 0.007

[c]Array had 6-in. polyethylene reflector.