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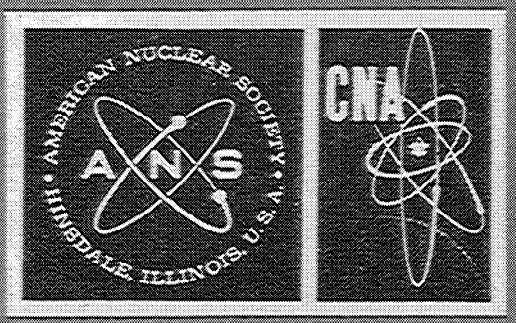

TRANSACTIONS

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8. Unreflected Plexiglas-Graphite-Uranium Critical Measurements*, *J. Carlton Hoogterp, (LASL)*

This series of measurements was stimulated by criticality questions associated with the processing and handling of graphite-uranium fuel for Rover reactors. It is directed specifically toward mixtures of this fuel with water or other hydrogenous material, in the hope of reducing large uncertainties attached to computed critical masses that had been used for safety guidance.

To simulate near-homogeneous mixtures of Rover fuel and water, unreflected critical parallelepipeds of U(93.16) moderated with Plexiglas or Plexiglas-graphite combinations were set up within the aluminum matrix of a split-table assembly machine. Initially, U(93.16) foils (0.002- to 0.012-in. thick) were interleaved with 1/16-in.-thick Plexiglas plates to yield H:^{235}U ratios of ~6, 12, and 36. Graphite plates (0.180- or 0.280-in. thick) were added later to obtain overall C:^{235}U ratios in the neighborhood of 24, 48, and 98. In some cases, effects of density changes were investigated, and in others, various shapes were intercompared.

Measured reactivity contributions of the various materials provided the basis for minor corrections of composition, and for eliminating effects of control-rod perturbations. Observed critical volumes were corrected to spherical shape for comparison with one-dimensional transport calculations using Hansen-Roach cross sections.[1] The shape conversions made use of Stratton's empirical expression for extrapolation distance[2]

$$\delta_1(\text{cm}) = 1.17 + 0.22 \log l^3 \quad ,$$

where l is a dimension, such as length or diameter, in centimeters.

Table I lists the observed critical parameters and the critical volumes of equivalent spheres. These spherical volumes, after correction to "standard" composition, are compared with computed values in Table II. The

*Sponsor: Hugh C. Paxton

TABLE I

Critical Parameters of Plexiglas-Graphite-U(93) Assemblies

	$\rho(^{235}\text{U})$	Atomic[a] Ratio		Dimension (in.)			Critical Volume (liters)	
	(g/cm^3)	H:^{235}U	C:^{235}U	L × H × W			Observed	Equivalent Sphere
1	2.303	6.0	3.76	23.5	12	9.26	42.8	25.8
2	2.096	6.0	3.74	23.5	12	10.10	50.8	33.3
3	1.317	12.1	7.6	15	12	11.38	33.6	27.6
4	0.480	35.1	21.9	15	12	12	35.4	29.3
5	0.917	6.0	24.3	23.5	18	18	124.8	100.1
6	0.521	6.0	48.5	23.5	24	27.53	254.4	207.5
7	0.258	12.3	98.7	23.5	28.5	28.70	315.0	254.8
8	0.258	12.4	98.2	32	24.75	24.65	319.8	253.0
9	0.258	12.4	98.2	32	13.61R[b]		305.1	262.7
10	0.336	35.2	48.2	15	15	16.69	61.5	51.5
11	0.223	35.5	99.4	15	21	21	108.4	84.6
Honeycomb Al matrix throughout core and as incidental reflector: $\bar{\rho}$(Al) = 0.165 g/cm^3.								

[a]Hydrogen content obtained from Plexiglas ($C_5H_8O_2$).
[b]Pseudo-cylinder.

TABLE II

Comparison of Adjusted Sphere Data and Computed Critical Volumes

Adjusted Parameters			Critical Sphere Volume (liters)	
$\rho(^{235}U)$ (g/cm^3)	H: ^{235}U	C: ^{235}U	Adjusted Value	Computed[a]
2.3	6	3.75	26.0	26.5
2.1	6	3.75	33.0	34.0
1.3	12	7.5	29.0	28.8
0.48	36	22.5	28.2	28.0
0.925	6	24	99.9	106.3
0.52	6	49	208.0	216.2
0.25	12	98	2.67.1,265.3,274.7	272.7
0.33	36	48	52.2	53.9
0.23	36	98	81.7	80.9

[a]Aluminum from assembly machine and oxygen from Plexiglas ($C_5H_8O_2$) included.

average difference between the compared critical volumes, about $2\frac{1}{2}\%$, is less than one-tenth the uncertainty that had been attached to computed values.

1. G. E. HANSEN and W. H. ROACH, "Six and Sixteen-Group Cross Sections for Fast and Intermediate Critical Assemblies," LAMS-2543, Los Alamos Scientific Lab. (1961).

2. W. R. STRATTON, "Critical Data Factors Affecting Criticality of Single Homogeneous Units," LA-3612, 7 (1967).