UPDATED SUMMARY OF MEASUREMENTS AND CALCULATIONS OF
NEUTRON AND GAMMA-RAY EMISSION SPECTRA FROM SPHERES
PULSED WITH 14-MeV NEUTRONS

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ABSTRACT

New measurements of the neutron and gamma-ray emission spectra from materials of interest to thermonuclear reactors with a 14 MeV neutron source were done during 1986 and 1987. These measurements characterized by better resolution than those reported in the Summary published in 1982 (UCID-19604), were performed using the pulsed sphere and time-of-flight techniques (see Ref. 7 in UCID-19604). The detector used in these measurements was a NE-213 cylinder, 5.08 cm in diameter by 5.08 cm thick.

The new measurements include the following materials: Be, C, N, H₂O, C₂F₄ (teflon), Al, Si, Ti, Fe, Cu, Ta, W, Au, Pb, ²³²Th, and ²³⁸U. For all these materials, both the neutron and gamma emission spectra were measured. A complete tabulation of all the measurements done under the Pulse Sphere Program is presented.

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MASTER

The Monte Carlo calculational analysis of these measurements has been done using the codes TART and SANDYL with the ENDL and ENDF/B-V photon neutron libraries. The results of these calculations, as well as the description of the measurements are discussed in the publications listed in the references.

A detailed description of all the new neutron and photon measurements and their comparisons with the calculations will be published shortly.

DISCLAIMER

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MATERIALS INCLUDED
IN THE PULSED SPHERE MEASUREMENTS

Material	Density [g/cm ³]	Radius [cm]	$\rho \times \Delta R^\dagger$ [g/cm ²]	Reference
Li-6	0.447	8.97	3.70	8,23
		16.52	7.04	
		25.52	11.02	
Li-7	0.503	8.97	4.16	8,23
		16.52	7.92	
		25.52	12.40	
Be-9	1.83	4.58 (R ₁ -R ₂)	8.38	8, 33-37
		8.48 (R ₁ -R ₂)	15.52	
		13.80 (R ₁ -R ₂)	25.25	
		19.90 (R ₁ -R ₂)	36.42	
C-Nat	1.873	4.19	7.60	1,17,23,36,37
	1.78	10.16*	17.85	
	1.847	20.96	38.47	
N-Nat	0.808	10.48	8.27	2,6,19,20,37
		19.05*	14.76	
		55.88	43.86	
		129.30	104.2	
O-Nat	1.14	10.50	11.66	17,36,37
Mg-Nat	1.74	8.94	14.44	8
		16.50	27.60	
		25.50	43.26	

*New measurements include both the neutron and gamma emission spectra.

†Thickness of the material at 0° traversed by the 14 MeV neutrons.

Material	Density [g/cm ³]	Radius [cm]	$\rho \times \Delta R^\dagger$ [g/cm ²]	Reference
Al-27	2.70	8.94*	22.41	17,18,36,37
		16.50	42.82	
		25.50	67.12	
Si-Nat	2.33	10.16*	21.10	37
Ti-Nat	4.54	8.94*	37.68	17,37
		16.50	72.00	
		25.50	112.86	
Fe-Nat	7.85	4.46*	31.32	9,11,18,22,36,37
		13.40	101.58	
		22.30	171.37	
Cu-Nat	8.96	4.00*	32.88	18,26,30,37
		12.00	103.22	
		20.00	174.90	
Nb-93	8.59	4.00	31.53	18,29,30
		14.61	121.19	
Sn-Nat	7.22	5.97	39.64	29
Ho-165	8.80	4.60	38.32	26,34
Ta-Nat	16.60	3.40*	51.13	26,29,34,36,37
		10.20	161.35	
W-Nat	19.95	10.36*(R ₁ -R ₂)	49.00	37

* New measurements include both the neutron and gamma emission spectra.

† Thickness of the material at 0° traversed by the 14 MeV neutrons.

Material	Density [g/cm ³]	Radius [cm]	$\rho \times \Delta R^\dagger$ [g/cm ²]	Reference
Au-197	19.30	6.21*	119.85	29,34,37
Pb-Nat	11.35	5.60* 8.97	60.15 94.55	37 34
Th-232	11.90	5.76*	67.71	26,28,30,37
U-235	18.55	3.145 5.925	49.53 109.91	28
U-238	19.04	3.64* 10.91	60.17 207.73	15,26,28-30,36,37
Pu-239	15.80	3.50 5.36	45.35 84.69	28

* New measurements include both the neutron and gamma emission spectra.

† Thickness of the material at 0° traversed by the 14 MeV neutrons.

COMPOUNDS

Material	Density [g/cm ³]	Radius [cm]	L[g/cm ²] [†]	Reference
Polyethylene (CH ₂)	0.92	16.50	6.96	8
		25.50	15.24	
		40.40	28.94	
Water (H ₂ O)	1.00	10.48*	10.25	22,23,36,37
		19.05	18.27	
Heavy Water (² H ₂ O)	1.105	10.48	11.30	8
		19.05	20.19	
Liquid Air (79%N,21%O)	0.878	19.05	16.06	20
		55.88	47.50	
		129.30	113.2	
Teflon CF ₂	2.22	7.56 (R ₁ -R ₂)	16.90	8
		16.50*	35.21	
		25.50	55.19	
Concrete**	2.35	21.00	37.37	10,22,23
		35.50	71.44	
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* New measurements include both the neutron and gamma emission spectra.

† Thickness of the material at 0° traversed by the 14 MeV neutrons.

** Composition: (55.72%O, 15.13%H, 14.87%Si, 33.6%Ca, 3.14%C, 1.76%Mg, 1.34%Na, 0.62%Fe, +...)

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