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LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA o LOS ALAMOS NEW MEXICO

LOS ALAMOS CRITICAL-MASS DATA

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LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

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LOS ALAMOS CRITICAL-MASS DATA

by

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ABSTRACT

Tabulated are critical masses of simple systems, which have been measured at Los Alamos through the year 1963.

TABLE OF CONTENTS

TABLES (Continued)

TABLES (Continued)

TABLES (Continued)

INTRODUCTION

Numerous Los Alamos critical mass data have been published only as points on curves, frequently after adjustment to "standard" conditions (e.g., to uniform values of U^{235} enrichment and density), and usually without indication of reliability. Under these conditions, original data tend to become lost. It is the purpose of this compilation to retrieve original critical masses and to give some means of judging the quality of measurements.

Indexes of accuracy are probable error, if it has been estimated, the maximum mass of fissile material used in the measurement, or the maximum central-source neutron multiplication attained. For nonhydrogenous systems a multiplication of 10 usually corresponds to a core mass that is 70% to 80% of critical, 20 corresponds to 85% to 90% of the critical mass, 50 corresponds to 93% to 97%, and 100 corresponds to 96-1/2% to 98-1/2%. Generally, the probable error in critical mass is about one-quarter of the difference between the critical mass value and the maximum mass employed. This estimate may be valid down to an indicated probable error of 1% to 2%, beyond which the probable error is usually controlled by the precision with which the composition and geometry of the system can be described. Maximum multiplication is not a reliable index of accuracy for hydrogen-moderated assemblies because of the severe influence of neutron-spectral distortion.

Not included in this compilation are several critical assemblies that cannot be described adequately by simple entries in tables (e.g., assemblies with nonuniform cores). Also omitted are a few critical mass estimates for which the maximum mass used was less than three-quarters of the critical value.

The following symbolism appears in the tables of critical masses:

m_c - critical mass of core

m_{max} - maximum mass used, in same units as m_c

M_{max} - maximum central source neutron multiplication attained

h_c - critical height of cylindric core

d - diameter of core

L x H x W - length times height times width of parallelepiped

ρ - density

w/o - weight percent

v/o - volume percent

U(93) - enriched uranium containing 93 w/o U^{235}

U(N) - uranium with natural isotopic composition

TABLE IA1

HIGHLY ENRICHED U METAL, UNREFLECTED

Corrected empirically for influence of supports and small (~0.4") source cavity unless noted otherwise

reference	shape	components	material	$\bar{\rho}$ (total U) (g/cm^3)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})	M_{max}
(1)	sphere[a]	thick sections	U(93.8)	18.75	-	48.8 ± 1/2%	critical	
(2)	sphere	thick shells	U(93.9)	18.75	-	48.7 ± 1/2%		142
(3)	pseudosphere	~0.4" rings[b]	U(93.9)	18.5 ± 0.1	-	50.9	49.8	150
(4)	psuedosphere	~0.4" rings[b]	U(93.9)	18.5 ± 0.1	-	50.6	50.0	180
(4)	cyl 4.75" dia	~0.4" rings[b]	U(93.8)	18.5 ± 0.1	-	>94	70.8	13
(4)	cyl 5.50" dia	~0.4" rings[b]	U(93.8)	18.5 ± 0.1	1.76	66.2	61.4	96
(4)	cyl 6.37" dia	~0.4" rings[b]	U(94.0)	18.5 ± 0.1	0.95	55.3	52.6	85
(4)	cyl 7.00" dia	~0.4" rings[b]	U(94.0)	18.5 ± 0.1	0.72	55.6	54.0	76
(4)	cyl 7.50" dia	~0.4" rings[b]	U(94.0)	18.5 ± 0.1	0.61	58.2	55.9	54
(5)	cyl 15.00" dia	0.3 cm plates	U(93.3)	17.9	0.214	155.3 ± 0.6	151	67
(5)	cyl 21.00" dia	0.3 cm plates	U(93.2)	17.9	0.141	281.2 ± 0.7	270	68

[a] Corrected for slight asphericity

[b] Uncorrected for 0.06 in.^{3} central source cavity; corrected empirically for effect of supports

TABLE IA2

U(93.4) - U(N) METAL CYLINDERS, UNREFLECTED

Indicated layers are combinations of 10.5" diameter, 0.8 cm thick U(93.4), and 0.6 cm thick U(N)

Corrected from partial terminating sandwich to fractional sandwich of proper composition

Corrected for reflection effect of support

All systems critical

Reference (6)

average composition	repeated layers, thickness (cm) U(93.4)	U(N)	$\bar{\rho}$ (total U) (g/cm^3)	diameter (in.)	h_c (in.)	h_c/d	m_c (kg U^{235})
U(53.6)	0.8[a]	0.6	18.7	10.50	6.10	0.581	86.8 ± 1/2%
U(37.7)	0.8	1.2[b]	18.75	10.50	10.04	0.956	100.7 ± 1/2%
U(29.0)	0.8	1.8[b]	18.8	11.42 av[c]	13.45	1.178	123.0 ± 1%

[a] Starts with 0.8 cm U(93.4) at base of stack

[b] Starts with 0.6 cm U(N) at base of stack

[c] Basic stack of plates extended by blocks of U(94) and U(N) in proper proportion

TABLE IA3

U(93.3) - U(N) METAL CYLINDERS, 15.00" DIAMETER, UNREFLECTED

Indicated layers, combinations of 0.3 cm thick U(93.3) and U(N), 0.6 cm U(N) or 1.5 cm U(N), start with U(N) at bottom and end with portion of sandwich at top

Average composition is that of final stack

Corrected for influence of supports of split stack

Communicated by G. A. Jarvis

average composition	repeated layers, thickness (cm) U(93.3)	U(N)	$\bar{\rho}$(total U) (g/cm^3)	h_c (in.)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
U (93.3)	0.3	0	18.06	3.18	0.212	155.2[a]	151
U (86.4)	3.6	0.3	18.08	3.36	0.224	152.1	146
U (83.4)	2.4	0.3	17.95	3.50	0.233	151.6	146
U (80.5)	1.8	0.3	17.98	3.60	0.240	150.8	146
U (77.7)	1.5	0.3	17.98	3.70	0.247	149.8	146
U (75.1)	1.2	0.3	18.19	3.77	0.252	149.1	146
U (70.5)	0.9	0.3	18.16	4.00	0.266	148.2	146
U (65.5)	3.6	1.5	18.33	4.05	0.270	140.8	136
U (64.4)	0.6	0.3	18.21	4.34	0.289	147.6	142
U (56.6)	2.4	1.5	18.37	4.60	0.306	138.5	136
U (57.1)[c]	2.1	1.5	18.34	4.66	0.311	141.2	137
U (50.5)	1.8	1.5	18.35	5.25	0.350	140.9	137
U (50.7)[c]	1.5	1.5	18.44	5.25	0.350	142.2	141
U (47.0)	0.6	0.6	18.42	5.53	0.369	138.8	134
U (47.1)	0.3	0.3	18.25	5.61	0.374	139.8	134
U (44.2)	1.2	1.5	18.49	5.92	0.394	140.1	137
U (38.0)	0.9	1.5	18.49	7.02	0.468	142.9	140
U (31.6)	0.3	0.6	18.51	8.23	0.548	139.2	135
U (28.9)	0.6	1.5	18.32	9.63	0.642	147.5	144
U (23.9)	(0.3, 0.3)	(1.5, 0.3)[b]	18.65	11.73	0.782	151.6	149
U (21.3)	(0.3, 0.3)	(1.5, 0.6)[b]	18.62	14.15	0.943	162.6	155
U (19.3)	(0.3, 0.3)	(1.5, 0.9)[b]	18.66	17.85	1.190	185.8	175

[a] Corrections not as detailed as those for next-to-last item in Table IA1

[b] The 1.5 cm U(N) plate was at base of stack; it alternates with the thinner U(N) in successive sandwiches

[c] Extra U(93.3) plates at top of stack

TABLE IB1

ENRICHED U METAL SPHERE OR PSEUDOSPHERE, U(N) REFLECTOR

	core				reflector				
reference	shape	components	material	$\bar{\rho}$ (total U) (g/cm^3)	shape	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	M_{max}
(7)	sphere	hemispheres	U(93.2)	18.62	sphere	7.09	19.0	16.65 ± 0.05	critical
(2)	sphere	nesting shells	U(93.9)	18.75	sphere	3.92	19.0	18.55 ± 0.1	167
(2)	sphere	nesting shells	U(93.9)	18.75	sphere	3.52	19.0	19.2 ± 0.2	53
(2)	sphere	nesting shells	U(93.9)	18.75	sphere	1.76	19.0	24.9 ± 0.15	141
(2)	sphere	nesting shells	U(93.9)	18.75	sphere	0.695	19.0	34.0 ± 0.15	156
(4)	pseudosphere	~0.4" rings	U(93.8)	18.5[a]	pseudosphere	1.87	18.7	24.6	160
(4)	pseudosphere	~0.4" rings	U(93.8)	18.5[a]	pseudosphere	0.99	18.7	32.4	34
(8)	pseudosphere	1/2" min blocks	U(94)	18.7	pseudosphere	11 av	19.0	16.2	critical
(9)	pseudosphere	1/2" min blocks	U(94.13)	18.7	pseudosphere	9 av	19.0	16.39 ± 0,07	critical
(9)	pseudosphere	1/2" min blocks	U(80.5)[b]	18.7	pseudosphere	8-3/4 av	19.0	18.3	critical
(9)	pseudosphere	1/2" min blocks	U(67.6)[b]	18.75	pseudosphere	8-1/2 av	19.0	20.8	critical
(9)	pseudosphere	1/2" min blocks	U(66.6)[b]	18.75	pseudosphere	8-1/2 av	19.0	21.2	critical
(9)	pseudosphere	1/2" min blocks	U(47.3)[b]	18.8	pseudosphere	7-3/4 av	19.0	27.1	critical
(9)	pseudosphere	1/2" min blocks	U(94)	16.0[c]	pseudosphere	8-3/4 av	19.0	19.7	critical
(9)	pseudosphere	1/2" min blocks	U(94)	15.8[c]	pseudosphere	8-3/4 av	19.0	20.1	critical
(9)	pseudosphere	1/2" min blocks	U(94)	13.1[c]	pseudosphere	8-1/4 av	19.0	25.3	critical
(9)	pseudosphere	1/2" min blocks	U(94)	9.35[c]	pseudosphere	7-1/4 av	19.0	37.0	critical
(10)	pseudosphere	1/2" min blocks	U(78.7)	~17.8	sphere	19 o.d.	19.0	21.9	critical

[a] Uncorrected for 0.06 in.^{3} central source cavity

[b] Average concentration of mixed 1/2" cubic units of U(94) and U(N)

[c] Average density with 1/2" cubic voids distributed throughout core; corrected experimentally for effect of tubular Al spacers within voids

TABLE IB2

ENRICHED U METAL CYLINDER, PSEUDOCYLINDER OR PARALLELEPIPED, U(N) REFLECTOR (LAST ITEM DEPLETED U)

	core				reflector					
reference	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	shape	av thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	m_{max} (kg U^{235})	M_{max}
(8)	pseudocylinder[a]	4.00 x ~4.5 av dia	U(94)	18.7	pseudosphere	~9 av	19.0	16.9	critical	
(8)	parallelepiped[a]	4.00 x 4.00 x ~3.5	U(94)	18.7	pseudosphere	~9 av	19.0	16.9	critical	
(8)	parallelepiped[a]	5.00 x 5.00 x ~2.5	U(94)	18.7	pseudosphere	~8-3/4 av	19.0	18.2	critical	
(8)	parallelepiped[a]	7.50 x 7.50 x ~1.5	U(94)	18.7	pseudosphere	~8-1/4 av	19.0	25.4	24.3	
(8)	parallelepiped[a]	7.50 x 3.00 x ~3.0	U(94)	18.7	pseudosphere	~8-1/2 av	19.0	19.8	critical	
(8)	parallelepiped[a]	6.00 x 3.50 x ~3.0	U(94)	18.7	pseudosphere	~8-3/4 av	19.0	18.2	critical	
(4)	cylinder[b]	3.98 dia, h_c/d = 3.51	U(93.7)	18.5	cylinder	1.12	18.7	49.5	~43	67
(4)	cylinder[b]	3.98 dia, h_c/d = 2.15	U(93.7)	18.5	cylinder	1.87	18.7	30.4	~30	200
(4)	cylinder[b]	4.75 dia, h_c/d = 1.38	U(93.8)	18.5	cylinder	1.12	18.7	33.0	~31.5	59
(4)	cylinder[b]	4.75 dia, h_c/d = 1.03	U(93.8)	18.5	cylinder	2.00	18.7	24.6	~24	100
(4)	cylinder[b]	5.50 dia, h_c/d = 0.84	U(93.8)	18.5	cylinder	1.12	18.7	31.3	~31	96
(4)	cylinder[b]	5.50 dia, h_c/d = 0.67	U(93.8)	18.5	cylinder	2.00	18.7	25.0	~24	96
(4)	cylinder[b]	6.37 dia, h_c/d = 0.565	U(94.0)	18.5	cylinder	1.12	18.7	32.4	~31.5	66
(4)	cylinder[b]	6.37 dia, h_c/d = 0.47	U(94.0)	18.5	cylinder	2.00	18.7	27.4	~26	43
(4)	cylinder[b]	7.00 dia, h_c/d = 0.46	U(94.0)	18.5	cylinder	1.12	18.7	35.3		38
(4)	cylinder[b]	7.50 dia, h_c/d = 0.41	U(94.0)	18.5	cylinder	1.12	18.7	38.0		107
(4)	pseudocylinder[a]	3.0 av dia, h_c/d = 3.08	U(94)	18.7	pseudosphere	~8 av	18.9	21.3	20.7	
(4)	pseudocylinder[a]	4.0 av dia, h_c/d = 1.00	U(94)	18.7	pseudosphere	~9 av	18.9	16.66	critical	
(4)	pseudocylinder[a]	6.5 av dia, h_c/d = 0.31	U(94)	18.7	pseudosphere	~8-1/2 av	18.9	20.3	19.6	
(4)	pseudocylinder[a]	8.3 av dia, h_c/d = 0.18	U(94)	18.7	pseudosphere	~7-3/4 av	18.9	25.7	24.9	
(11)	cylinder[c]	5.25 dia, h_c/d = 1.25	U(93.3)	18.75	cylinder	0.500	18.8	40.7 ± 0.1		1000
(11)	cylinder[c]	5.25 dia, h_c/d = 0.965	U(93.3)	18.75	cylinder	1.000	18.8	31.4 ± 0.1		500
(12)	cylinder[d]	15.00 dia, h_c/d = 0.91	U(93.4)	17.7	cylinder	3.00	18.9	65.4 ± 1.0		52
(12)	cylinder[e]	3.24 dia, h_c/d = 8.8	U(93.2)	18.7	cylinder	2.75	18.9	65.5 ± 1.0		52
(13)	cylinder[f]	15.00 dia x 12.75	U(18.25)	18.75	cylinder	3.00	19.0	112.5 ± 0.7	critical	

[a] Core of 1/2" min blocks

[b] Core of ~0.4" nesting rings; uncorrected for 0.08 in.^{3} central source cavity

[c] Core of discs 1.20" to 0.075" thick; m_c corrected empirically for incidental reflection, diaphragm supporting part of assembly, and 0.05 in.^{3} central cavity

[d] Core of 0.3 cm discs of U(93.4). m_c corrected for influence of support structure

[e] Core of thick plates; reflector U depleted to ~0.3% U^{235}

[f] Core of alternating 0.3 cm discs of U(93.4) and 1.5 cm discs of U(N)

TABLE IB3

MISCELLANEOUS ENRICHED U METAL, U(N) REFLECTOR[a]

reference	core	reflector	m_c kg U^{235}
(14)	annulus, 12.25" o.d. x 6.00" i.d. x 3.01" high, stack of 1/2" and 1/4" thick rings U(93.4), $\bar{\rho}$(U) = 18.7 g/cm^3	1.00" thick, $\bar{\rho}$ = 19.0 g/cm^3, completely envelops core	77.2 ± 0.3 ($m_{max} > m_c$)[b]
(14)	annulus, 12.25" o.d. x 6.00" i.d. x 2.03" high, stack of 1/2" and 1/4" thick rings U(93.4), $\bar{\rho}$(U) = 18.7 g/cm^3	3.00" thick, $\bar{\rho}$ = 19.0 g/cm^3, completely envelops core	52.2 ± 0.3 (m_{max} = 51.6)
(15)	pseudocylinder, 13.74" av dia x 12.00" av composition:[c] 18.1 v/o U(93.6), $\bar{\rho}$ = 3.38 g/cm^3; 13.6 v/o U(N), $\bar{\rho}$ = 2.58 g/cm^3; 11.8 v/o Fe, $\bar{\rho}$ = 0.92 g/cm^3; 52.3 v/o Al, $\bar{\rho}$ = 1.40 g/cm^3; 4.2 v/o void	pseudocylinder 5.0" av thickness, $\bar{\rho}$ = 18.9 g/cm^3	93.0 (M_{max} = 225)

[a] Unlisted, is a nonuniform assembly of mixed plates and rings of U(93.4) and U(N) that enclose a near-central cylindrical cavity, 15.0" dia x 11.8"; outside dimensions of the assembly are 21.0" dia x ~21" high (S. J. Balestrini, G. A. Jarvis, J. D. Orndoff, December 1961). Average composition bounding cavity is U(27), ~4-1/2" thick U(N) rings form top and bottom of cylinder. At critical, the total mass is ~1400 kg U(N) and 339 kg U(93.4). Uncorrected for 1/4" thick steel plate supporting portion above cavity.

[b] Corrected for small gap between assembly halves

[c] Average thickness of core discs, blocks, and shaped Al fillers: U(93.6) ~0.4", U(N) ~0.3", Fe ~0.25", Al ~0.9"

TABLE IC1

HIGHLY ENRICHED U METAL, REFLECTOR OF Th, W, WC, Mo OR Mo_2C

	core				reflector						
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	material	shape	thickness (in.)	$\bar{\rho}$ (total) (g/cm^3)	m_c (kg U^{235})	m_{max} (kg U^{235})	M_{max}
(11)	sphere	(nesting shells)	U(93.9)	18.6	Th	sphere	1.81	11.48	34.7 ± 0.2	34.2	162
(16)	cylinder	5.967 dia, h_c/d = 0.59	U(93.16)	18.75	Th	(21.0" equilateral cyl)		11.9	28.0 ± 0.3	26.9	
(11)	sphere	(nesting shells)	U(93.9)	18.75	W-alloy[a]	sphere	2.00	17.39	24.1 ± 0.2		159
(11)	sphere	(nesting shells)	U(93.9)	18.75	W-alloy[a]	sphere	4.00	17.39	19.4	18.3	44
(11)	cylinder	5.25 dia, h_c/d = 1.25[b]	U(93.3)	18.75	W-alloy[c]	cylinder	0.500	17.3	40.6 ± 0.1		1250
(11)	cylinder	5.25 dia, h_c/d = 0.97[b]	U(93.3)	18.75	W-alloy[c]	cylinder	1.000	17.3	31.75 ± 0.1		128
(17)	cylinder	4.25 dia	U(93.5)	18.7	W-alloy[d]	cylinder	2.00, but one end 3.00	17.3	27.36	critical	
(8)	sphere	(shells) 0.83 i.d.	U(93.9)	18.45	WC	pseudosphere	2.9 av	~14.7	18.7	15.1	13
(8)	sphere	(shells) 0.83 i.d.	U(93.9)	18.45	WC	pseudosphere	4.5 av	~14.7	16.6	15.1	29
(8)	sphere	(shells) 0.83 i.d.	U(93.9)	18.45	WC	pseudosphere	6.5 av	~14.7	16.3	15.1	36
(10)	pseudosphere	(1/2" min blocks)	U(78.5)	17.8	WC	(14" cube)		14.7	20.8[e]	critical	
(17)	cylinder	4.25 dia	U(93.5)	18.7	WC	cylinder	2.00	~14.7	24.4	23.6	80
(11)	cylinder	5.25 dia, h_c/d = 1.29[b]	U(93.3)	18.75	Mo (99.8 w/o)	cylinder	0.500	10.53	41.7		210
(11)	cylinder	5.25 dia, h_c/d = 1.01[b]	U(93.3)	18.75	Mo (99.8 w/o)	cylinder	1.000	10.53	32.9		141
(11)	cylinder	5.25 dia, h_c/d = 1.23[b]	U(93.3)	18.75	Mo_2C[f]	cylinder	0.500	9.57	39.9		270
(11)	cylinder	5.25 dia, h_c/d = 0.95[b]	U(93.3)	18.75	Mo_2C[f]	cylinder	1.000	9.57	30.9		110

[a] Composition 90 w/o W, 7 w/o Ni, 3 w/o Cu

[b] Core of discs 1.20" to 0.075" thick; m_c corrected empirically for incidental reflection, diaphragm supporting part of assembly, and 0.05 in.^{3} central cavity

[c] Composition 91.3 w/o W, 5.5 w/o Ni, 2.5 w/o Cu, 0.7 w/o Zr

[d] Composition 92 w/o W, 5.5 w/o Ni, 2.5 w/o Cu

[e] For cylinders in this reflector, m_c/m_c (sphere) = 0.98, 0.96, 0.93 when h_c/d = 0.92, 0.63, 1.60, respectively

[f] Composition 95 to 96 w/o Mo_2C, 4 to 5 w/o Ni

TABLE IC2

HIGHLY ENRICHED U METAL, REFLECTOR OF Zn, Cu, Ni, Co, OR Fe

	core				reflector						
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	material	shape	thickness (in.)	$\bar{\rho}$ (total) (g/cm^3)	m_c (kg U^{235})	m_{max} (kg U^{235})	M_{max}
(11)	sphere	(nesting shells)	U(93.9)	18.7	Zn	sphere	2.00	7.04	30.0	28.5	52
(11)	sphere	(nesting shells)	U(93.9)	18.5	Zn	sphere	4.075	7.04	25.4 ± 0.3	23.9	46
(11)	sphere	(nesting shells)	U(93.9)	18.75	Cu	sphere	2.00	8.88	25.4 ± 0.2		118
(11)	sphere	(nesting shells)	U(93.9)	18.75	Cu	sphere	4.175	8.88	20.7 ± 0.2		141
(11)	cylinder	5.25 dia, h_c/d = 1.29[a]	U(93.3)	18.75	Cu[b]	cylinder	0.500	8.87	42.16 ± 0.1		330
(11)	cylinder	5.25 dia, h_c/d = 1.03[a]	U(93.3)	18.75	Cu[b]	cylinder	1.000	8.87	33.44 ± 0.1		190
(8)	pseudosphere	(1/2" min blocks)	U(94.0)	18.7	"A"-Ni	pseudosphere	8-3/4 av	8.88	19.9	critical	
(11)	sphere	(nesting shells)	U(93.9)	18.4	Ni	sphere	2.00	8.35	27.6	25.9	42
(11)	cylinder	5.25 dia, h_c/d = 1.29[a]	U(93.3)	18.75	Ni (elect)	cylinder	0.500	8.79	42.0		170
(11)	cylinder	5.25 dia, h_c/d = 1.04[a]	U(93.3)	18.75	Ni (elect)	cylinder	1.000	8.79	34.0		190
(11)	cylinder	5.25 dia, h_c/d = 1.27[a]	U(93.3)	18.75	Co (reag)	cylinder	0.500	8.72	41.5		102
(11)	cylinder	5.25 dia, h_c/d = 1.02[a]	U(93.3)	18.75	Co (reag)	cylinder	1.000	8.72	33.3		117
(11)	sphere	(nesting shells)	U(93.9)	18.6	Fe (cast)	sphere	2.00	7.18	29.7 ± 0.3	28.5	59
(11)	sphere	(nesting shells)	U(93.9)	18.4	Fe (cast)	sphere	4.00	7.16	26.0 ± 0.2		143
(18)	sphere	(thick shells)	U(93.9)	18.52	steel	(80" cube)		~7.7	23.4		64
(11)	cylinder	5.25 dia, h_c/d = 1.42[a]	U(93.3)	18.75	Fe[c]	cylinder	0.500	7.78	46.3 ± 0.2		105
(11)	cylinder	5.25 dia, h_c/d = 1.18[a]	U(93.3)	18.75	Fe[c]	cylinder	1.000	7.78	38.38 ± 0.1		340
(17)	cylinder	4.25 dia	U(93.5)	18.7	Fe[c]	cylinder	4.00	7.78	33.8	26.9	13

[a] Core of discs 1.20" to 0.075" thick; m_c corrected empirically for incidental reflection, diaphragm supporting part of assembly, and 0.05 in.^{3} central cavity

[b] Cast Cu, 1/2 to 1 w/o impurity

[c] Steel, SAE 1020

TABLE 1C3

HIGHLY ENRICHED U METAL, REFLECTOR OF Ti, Al, Al_2O_3, Mg, Be, OR BeO

	core				reflector					
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	material	shape	thickness (in.)	$\bar{\rho}$ (total) (g/cm^3)	m_c (kg U^{235})	M_{max}
(11)	cylinder	5.25 dia, h_c/d = 1.61[a]	U(93.3)	18.75	Ti[b]	cylinder	0.500	4.50	52.4 ± 0.6	16
(11)	cylinder	5.25 dia, h_c/d = 1.38[a]	U(93.3)	18.75	Ti[b]	cylinder	1.000	4.50	45.0 ± 0.1	125
(19)	sphere	(nesting shells)	U(93.18)	18.40	Al (2014)	sphere	2.610 ± 0.03	2.82	34.71 ± 0.1	170
(11)	cylinder	5.25 dia, h_c/d = 1.59[a]	U(93.3)	18.75	Al (2S)	cylinder	0.500	2.70	52.0 ± 0.8	17
(11)	cylinder	5.25 dia, h_c/d = 1.35[a]	U(93.3)	18.75	Al (2S)	cylinder	1.000	2.70	44.1 ± 0.1	200
(11)	cylinder	5.25 dia, h_c/d = 1.40[a]	U(93.3)	18.75	Al_2O_3	cylinder	0.500	2.76	45.5	~100
(11)	cylinder	5.25 dia, h_c/d = 1.14[a]	U(93.3)	18.75	Al_2O_3	cylinder	1.000	2.76	37.2	~150
(11)	cylinder	5.25 dia, h_c/d = 1.66[a]	U(93.3)	18.75	Mg (FS-1)	cylinder	0.500	1.77	54.2 ± 0.7	13
(11)	cylinder	5.25 dia, h_c/d = 1.46[a]	U(93.3)	18.75	Mg (FS-1)	cylinder	1.000	1.77	47.7 ± 0.3	34
(11)	sphere	(nesting shells)	U(93.9)	18.5	Be	sphere	1.85	1.84	22.2 ± 0.2	100
(11)	sphere	(nesting shells)	U(93.9)	18.75	Be	sphere	1.89	1.84	21.6	24
(11)	sphere	(nesting shells)	U(93.8)	18.8	Be	sphere	4.64	1.84	13.1 ± 0.2[c]	143
(11)	cylinder	5.25 dia, h_c/d = 1.19[a]	U(93.3)	18.75	Be (QMV)	cylinder	0.500	1.84	38.89 ± 0.1	480
(11)	cylinder	5.25 dia, h_c/d = 0.90[a]	U(93.3)	18.75	Be (QMV)	cylinder	1.000	1.84	29.28 ± 0.1	210
(12)	cylinder	15.00 dia, h_c/d = 0.131	U(93.4)	17.7	Be	cylinder	1.00	1.80	93.9 ± 0.9	25
(12)	cylinder	15.00 dia, h_c/d = 0.090	U(93.4)	17.7	Be	cylinder	2.00	1.80	64.9 ± 1.0	23
(12)	cylinder	15.00 dia, h_c/d = 0.068	U(93.4)	17.7	Be	cylinder	3.00	1.80	49.0 ± 1.0	35
(12)	cylinder	15.00 dia, h_c/d = 0.053	U(93.4)	17.7	Be	cylinder	4.00	1.80	37.8 ± 0.5	13
(12)	cylinder	15.00 dia, h_c/d = 0.042	U(93.4)	17.7	Be	cylinder	5.00	1.80	30.4 ± 0.5	15
(11)	pseudosphere	(1/2" min blocks)[d]	U(94)	18.7	BeO	pseudosphere	2.35 av	2.69	19.7	85
(11)	pseudosphere	(1/2" min blocks)[d]	U(94)	18.7	BeO	pseudosphere	3.5 av	2.69	16.5	105
(10)	pseudosphere	(1/2" min blocks)	U(82.7)	17.8	BeO	(24" cube)		~2.69	10.3	critical

[a] Core of discs 1.20" to 0.075" thick; m_c corrected empirically for incidental reflection, diaphragm supporting part of assembly, and 0.05 $in.^3$ central cavity

[b] Composition 98.5 w/o Ti, 2.5 w/o Cr, 1 w/o Fe

[c] With 0.010" Cd between core and reflector, m_c = 14.0 kg U^{235} (M_{max} = 21)

[d] Uncorrected for 0.06 $in.^3$ central source cavity

TABLE IC4a

HIGHLY ENRICHED U METAL, COMPLETE GRAPHITE REFLECTOR

Graphite is grade CS-312 except as noted

	core				reflector				
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	shape	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	M_{max}
(20)	sphere	(nesting shells)[a]	U(93.9)	18.7	sphere	2.00	1.67	29.6 ± 0.3	58
(20)	sphere	(nesting shells)[a]	U(93.9)	18.7	sphere	4.00	1.67	24.3 ± 0.2	150
(20)	sphere	(nesting shells)[a]	U(93.9)	18.45	sphere	6.00	1.67	21.5 ± 0.2	150
(20)	sphere	(nesting shells)[a]	U(93.9)	18.75	sphere	8.00	1.67	19.5 ± 0.3	42
(20)	sphere	(nesting shells)[a]	U(93.9)	18.5	pseudosphere[b]	17 av	1.66	17.0	48
(20)	cylinder	3.25 dia, h_c/d = 2.95[c]	U(93.7)	18.5	pseudosphere[b]	17 av	1.68	22.5	17
(20)	pseudocylinder	3.82 av dia, h_c/d = 1.85[d]	U(94)	18.7	pseudosphere[b]	17 av	1.66	20.1	40
(20)	cylinder	3.98 dia, h_c/d = 1.30[c]	U(93.7)	18.5	pseudosphere[b]	17 av	1.66	18.3	109
(20)	cylinder	4.75 dia, h_c/d = 0.815[c]	U(93.7)	18.5	pseudosphere[b]	17 av	1.68	17.5	82
(20)	cylinder	5.50 dia, h_c/d = 0.495[c]	U(93.8)	18.5	pseudosphere[b]	17 av	1.66	18.5	78
(20)	cylinder	6.375 dia, h_c/d = 0.345[c]	U(94.0)	18.5	pseudosphere[b]	17 av	1.68	20.0	107
(20)	cylinder	7.50 dia, h_c/d = 0.235[c]	U(94.0)	18.5	pseudosphere[b]	17 av	1.66	22.7	150
(20)	pseudocylinder	h = 1.50, h_c/d = 0.177[d]	U(94.0)	18.7	pseudosphere[b]	17 av	1.68	24.6	90
(20)	pseudocylinder	h = 1.00, h_c/d = 0.081[d]	U(94.0)	18.7	pseudosphere[b]	17 av	1.66	34.8	200
(11)	cylinder	5.25 dia, h_c/d = 1.42[e]	U(93.3)	18.75	cylinder	0.500	1.67	48.35 ± 0.2	51
(11)	cylinder	5.25 dia, h_c/d = 1.18[e]	U(93.3)	18.75	cylinder	1.000	1.67	37.71 ± 0.1	>500
(12)	cylinder	3.24 dia, h_c/d = 8.79	U(93.2)	18.7	cylinder	4.85	1.60	51.7 ± 0.9	233
(12)	cylinder	3.24 dia, h_c/d = 4.97	U(93.2)	18.7	cylinder	5.75	1.60	37.9 ± 0.7	1350
(12)	cylinder	3.24 dia, h_c/d = 4.41	U(93.2)	18.7	cylinder	8.25	1.60	33.6 ± 0.7	460
(12)	cylinder	15.00 dia, h_c/d = 0.073[f]	U(93.4)	17.7	cylinder	7.00	1.60	52.1 ± 1.0	20
(21)	cylinder	10.50 dia, h_c/d = 0.192[g]	U(93.4)	18.7	cylinder	2.00	1.68	50.0	18
(14)	annulus	12.25 o.d. x 8.00 i.d. x 2.86	U(93.4)	18.7	(envelops core)	2.00	~1.67	73.3 ± 0.3	(m_{max} = 71.0)

[a] Uncorrected for 0.05 in.^{3} central source cavity

[b] Pile-grade graphite surrounds ~5" thick CS-312

[c] Interlocking rings; uncorrected for 0.08 in.^{3} central source cavity

[d] Formed of 1/2" min blocks

[e] Core of discs 1.20" to 0.075" thick; m_c corrected empirically for incidental reflection, diaphragm supporting part of assembly, and 0.05 in.^{3} central cavity

[f] Core of 0.3 cm thick plates; empirical correction for diaphragm supporting part of assembly

[g] Core of 0.315" thick plates; empirical correction for diaphragm supporting part of assembly

TABLE IC4b

HIGHLY ENRICHED U METAL, PARTIAL GRAPHITE REFLECTOR

Reflector same diameter as core where on ends only

Corrected empirically for diaphragm supporting part of assembly, for incidental reflection, and for small source cavity (no correction required for last item)

	core				reflector				
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	surfaces reflected	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	M_{max}
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	1.00	1.79	135.5 ± 0.5	123
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	1.00	1.73	242.3 ± 0.7	60
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	2.00	1.79	125.4 ± 0.5	46
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	2.00	1.73	222.3 ± 0.6	140
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	6.00	1.70	114.9 ± 0.4	135
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	6.00	1.76	192.3 ± 0.6	98
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	both planes	6.00	1.7	75.4 ± 0.3	37
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	both planes	6.00	1.7	103.5 ± 0.3	46
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	7.00	1.71	113.9 ± 0.4	43
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	7.00	1.76	190.2 ± 0.6	95
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	both planes	7.00	1.7	73.0 ± 0.3	107
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	both planes	7.00	1.7	99.4 ± 0.3	48
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	8.00	1.72	113.2 ± 0.4	55
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	8.00	1.75	188.4 ± 0.6	101
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	12.00	1.70	113.4 ± 0.4	52
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	12.00	1.76	185.7 ± 0.6	67
(5)	cylinder	15.00 dia	U(93.3)	17.9 ± 0.2	top plane	14.00	1.71	113.3 ± 0.4	54
(5)	cylinder	21.00 dia	U(93.2)	18.2 ± 0.2	top plane	14.00	1.76	185.3 ± 0.6	76
(21)	cylinder	10.50 dia, h_c/d = 0.226	U(93.4)	18.7	both planes	2.00	1.68	58.7	20
(22)	annulus	21.00 o.d. x 15.00 i.d. x 3.44	U(93.16)	17.9	(across both planes)	6.00	1.7	164.6	330
(23)	annulus	6.14 o.d. x 3.85 i.d. x 6.36	U(93.15)	18.7	top, bottom, wall (none inside)	9.5 8.9	1.67	32.7 ± 0.3	28

TABLE IC5

HIGHLY ENRICHED U METAL, REFLECTOR OF D_2O (99.8%)[24]

core				reflector (sphere)			
shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	thickness (in.)	container	m_c (kg U^{235})	M_{max}
sphere	(nesting shells)	U(93.9)[a]	18.5	3.28	0.04" ss	23.3	36
sphere	(nesting shells)	U(93.9)[a]	18.5	4.59	0.10" Al	20.5	22
sphere	(nesting shells)	U(93.9)[a]	18.5	5.50	0.04" ss	19.0	55
sphere	(nesting shells)	U(93.9)[a]	18.5	6.84	0.04" ss	17.1	40
sphere	(nesting shells)	U(93.7)[a]	18.5	15.3	0.2" ss	13.4	>400
sphere surrounded by 0.010" Cd	(nesting shells)	U(93.9)[a]	18.5	6.7	0.04" ss	20.9	m_{max} = 18.0
sphere surrounded by 0.010" Cd	(nesting shells)	U(93.9)[a]	18.5	15.1	0.2" ss	20.2	m_{max} = 18.0
hollow sphere, filled with D_2O	3.60 i.d.	U(93.9)	18.5	14.9	0.2" ss	16.4	16
hollow sphere, filled with D_2O	4.08 i.d.	U(93.7)	18.5	14.7	0.2" ss	17.2	32
hollow sphere, filled with D_2O	4.97 i.d.	U(93.7)	18.5	14.4	0.2" ss	18.3	18

[a] Empirical correction for small central source cavity

TABLE 1C6a

HIGHLY ENRICHED U METAL, COMPLETE REFLECTOR OF H_2O OR POLYETHYLENE
See also first item of Table 11F3

	core				reflector					
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	material	shape	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	N_{max}
(25)	sphere	(shells) 0.83 i.d.	U(93.9)	18.5	H_2O	cylinder	>12	1.00	23.4	49
(25)	sphere surrounded by 0.010" Cd	(shells) 0.83 i.d.	U(93.9)	18.4	H_2O	cylinder	>12	1.00	32.9	32
(20)	sphere	(nesting shells)[a]	U(93.9)	18.5	H_2O	cylinder	>12	1.00	23.2	154
(24)	sphere	(nesting shells)[a]	U(93.9)	18.5	H_2O	sphere	3.25	1.00	23.5	35
(24)	hollow sphere, filled with H_2O	3.60 i.d.	U(93.9)	18.5	H_2O	sphere	14.6	1.00	25.1	40
(24)	hollow sphere, filled with H_2O	4.08 i.d.	U(93.9)	18.5	H_2O	sphere	14.4	1.00	26.3	80
(24)	hollow sphere, filled with H_2O	4.68 i.d.	U(93.8)	18.5	H_2O	sphere	14.3	1.00	27.7	19
(20)	cylinder	3.98 dia, h_c/d = 1.90[a]	U(93.7)	18.5	H_2O	cylinder	>12	1.00	26.7	200
(20)	cylinder	4.75 dia, h_c/d = 0.98[a]	U(93.8)	18.5	H_2O	cylinder	>12	1.00	23.7	101
(20)	cylinder	5.50 dia, h_c/d = 0.86[a]	U(93.8)	18.5	H_2O	cylinder	>12	1.00	24.4	200
(20)	cylinder	6.375 dia, h_c/d = 0.46[a]	U(94.0)	18.5	H_2O	cylinder	>12	1.00	25.9	150
(20)	cylinder	7.00 dia, h_c/d = 0.365[a]	U(94.0)	18.5	H_2O	cylinder	>12	1.00	27.7	108
(20)	cylinder	7.50 dia, h_c/d = 0.300[a]	U(94.0)	18.5	H_2O	cylinder	>12	1.00	29.0	53
(21)	annulus	6.14 o.d. x 3.85 i.d. x 5.75[b]	U(93.15)	18.75	H_2O	cylinder	>12	1.00	29.6 ± 0.5	35
(26)	hemishell, segmented	12.0 o.d., 10.0 i.d.	U(93.5)	18.75	H_2O	cylinder	>6	1.00	56	20
(12)	cylinder	3.24 dia, h_c/d = 12.2	U(93.2)	18.7	H_2O	cylinder	>12	1.00	93.2 ± 5	43
(12)	cylinder	15.00 dia, h_c/d = 0.082[c]	U(93.4)	17.7	H_2O	cylinder	>12	1.00	59.0 ± 0.5	170
(11)	cylinder	5.25 dia, h_c/d = 1.34[d]	U(93.3)	18.75	polyethylene	cylinder	0.500	0.921	43.7	140
(11)	cylinder	5.25 dia, h_c/d = 1.00[d]	U(93.3)	18.75	polyethylene	cylinder	1.000	0.921	32.7	140
(12)	cylinder	3.24 dia, h_c/d = 8.0	U(93.2)	18.7	polyethylene	cylinder	4.00	0.92	61.3 ± 0.9	161
(12)	cylinder	15.00 dia, h_c/d = 0.095[c]	U(93.4)	17.7	polyethylene	cylinder	2.00	0.92	68.4 ± 0.9	79
(14)	annulus	12.25 o.d. x 6.00 i.d. x 2.20	U(93.4)	18.7	polyethylene	(envelops core)	3.00	0.92	56.8 ± 0.3	$m_{max} > m_c$[e]

[a] Uncorrected for 0.05 $in.^3$ central source cavity

[b] Water fills annulus

[c] Core of 0.3 cm plates; empirical correction for small source cavity and diaphragm supporting part of assembly (not used with H_2O reflector)

[d] Empirical correction for small central cavity and support effects

[e] Corrected for small gap in final configuration

TABLE IC6b

HIGHLY ENRICHED U METAL, COMPLETE REFLECTOR OF PARAFFIN

Paraffin reflector cylindrical, >8" thick, $\overline{\rho}$ = 0.89 g/cm^3

ref	core: shape	core: dimensions (in.)	core: material	core: $\overline{\rho}$ (total U) (g/cm^3)	m_c (kg U^{235})	M_{max}
(20)	sphere	(nesting shells)[a]	U(93.9)	18.5	22.2	62
(25)	sphere	(shells), 0.83 i.d.	U(93.9)	18.5	22.8	69
(20)	cylinder	3.25 dia, h_c/d = 4.4[b]	U(93.7)	18.5	35	11
(20)	cylinder	3.98 dia, h_c/d = 1.80[b]	U(93.7)	18.5	25.0	77
(20)	cylinder	4.75 dia, h_c/d = 0.915[b]	U(93.8)	18.5	22.2	108
(20)	cylinder	5.50 dia, h_c/d = 0.605[b]	U(93.8)	18.5	22.4	123
(20)	cylinder	6.375 dia, h_c/d = 0.45[b]	U(94.0)	18.5	24.5	200
(20)	cylinder	7.50 dia, h_c/d = 0.280[b]	U(94.0)	18.5	26.9	86

[a] Uncorrected for 0.05 in.^{3} central source cavity

[b] Interlocking rings ~0.4" thick, uncorrected for 0.05 in.^{3} central source cavity

TABLE IC6c

HIGHLY ENRICHED U METAL, PARTIAL REFLECTOR OF H_2O, POLYETHYLENE, LUCITE, OR PARAFFIN (5)

Reflector same diameter as core

Core of 0.3 cm plates and rings; m_c corrected empirically for diaphragm supporting part of assembly, for incidental reflection, and for small central source cavity

core			reflector					
cylinder dia (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	material	surfaces reflected	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	M_{max}
15.00	U(93.3)	17.9 ± 0.2	H_2O[a]	top plane	6.00	1.00	109.6 ± 0.4	250
21.00	U(93.2)	18.2 ± 0.2	H_2O[a]	top plane	6.00	1.00	188.5 ± 0.7	99
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	1.00	0.925	128.2 ± 0.5	167
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	1.00	0.925	228.4 ± 0.6	125
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	2.00	0.925	113.6 ± 0.4	57
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	2.00	0.925	198.5 ± 0.6	35
15.00	U(93.3)	17.9 ± 0.2	polyethylene	both planes	2.00	0.925	73.1 ± 0.3	73
21.00	U(93.2)	18.2 ± 0.2	polyethylene	both planes	2.00	0.925	117.4 ± 0.3	90
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	3.00	0.925	109.3 ± 0.4	77
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	3.00	0.925	190.3 ± 0.6	280
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	4.00	0.925	108.5 ± 0.4	75
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	4.00	0.925	188.5 ± 0.6	160
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	6.00	0.925	108.7 ± 0.4[b]	99
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	6.00	0.925	187.9 ± 0.6[c]	195
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	8.00	0.925	108.5 ± 0.4	110
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	8.00	0.925	187.8 ± 0.6	245
15.00	U(93.3)	17.9 ± 0.2	polyethylene	top plane	10.00	0.925	108.5 ± 0.4	120
21.00	U(93.2)	18.2 ± 0.2	polyethylene	top plane	10.00	0.925	187.6 ± 0.6	102
15.00	U(93.3)	17.9 ± 0.2	lucite	top plane	6.00	1.18	106.4 ± 0.4	52
21.00	U(93.2)	18.2 ± 0.2	lucite	top plane	6.00	1.18	182.1 ± 0.6	74
15.00	U(93.3)	17.9 ± 0.2	paraffin	top plane	6.00	0.87	109.2 ± 0.4	130
21.00	U(93.2)	18.2 ± 0.2	paraffin	top plane	6.00	0.87	188.5 ± 0.6	49

[a] Empirical correction for effect of 1/16" Al tank containing water, via influence of the tank containing lucite

[b] Critical mass 129.0 ± 0.5 (M_{max} - 170) when 0.015" Cd between core and reflector

[c] Critical mass 228.4 ± 0.6 (M_{max} - 38) when 0.015" Cd between core and reflector

TABLE IC7

HIGHLY ENRICHED U, MIXED REFLECTOR[a]

	core				reflector					
ref	shape	dimensions (in.)	material	$\bar{\rho}$ (total U) (g/cm^3)	shape	thickness (in.)	material	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	M_{max}
(27)	sphere	(nesting shells)[b]	U(93.9)	18.4	sphere	1.88	40 w/o Cu 32 w/o Ni 28 w/o Zn	8.55	26.7	89
(27)	sphere	(nesting shells)[b]	U(93.9)	18.75	sphere	2.02	40 w/o Cu 32 w/o Ni 28 w/o Zn	8.55	25.7	46
(28)	sphere	(shells) 0.83 i.d.	U(93.9)	18.45	inside: sphere outside: sphere	(9.00 o.d.) (18.5 o.d.)	U(N) Al	19.0 2.7	20.2	22
(29)	sphere	(shells) 0.83 i.d.	U(93.9)	18.5	inside: sphere outside: sphere	(9.00 o.d.) (13.7 o.d.)	U(N) Al	19.0 2.7	21.8	65
(29)	sphere	(shells) 0.83 i.d.	U(93.9)	18.5	inside: sphere outside: sphere	(9.00 o.d.) (13.7 o.d.)	U(N) Be	19.0 1.84	17.7	300
(30)	sphere	(thick shells)	U(93.2)	18.4	inside: sphere outside: sphere	0.50 1.30_5	U(N) Be	19.0 1.84	23.0	$m_{max} > m_c$[d]
(11)	sphere	(nesting shells)[b]	U(93.5)	18.8	inside: sphere outside: sphere	2.00 2.00	W-alloy[c] cast iron	17.39 7.16	21.0 ± 0.5	20
(11)	cylinder	5.25 dia, h_c/d = 0.99	U(93.3)	18.75	inside: cylinder outside: cylinder	0.500 0.500	Be Fe	1.84 7.78	32.4	102
(14)	annulus	12.25 o.d., 6.00 i.d., h_c = 1.98	U(93.4)	18.7	inside: (envelops outside: core)	1.00 2.00	U(N) polyethylene	19.0 0.92	50.9	$m_{max} > m_c$[d]
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	2.0 (31 lb)	concrete[e]	~2.3	127.9[f]	96
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	4.0 (58 lb)	concrete[e]	~2.3	119.5[f]	10
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	6.0 (89 lb)	concrete[e]	~2.3	117.5[f]	20
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	8.0 (116 lb)	concrete[e]	~2.3	116.4[f]	29
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	12.0 (178 lb)	concrete[e]	~2.3	116.1[f]	35
(31)	cylinder	15.00 dia	U(93.3)	17.7	(cyl, top plane only)	28.0 (406 lb)	concrete[e]	~2.3	115.8[f]	40

[a] Note: Hansen, G. E., Wood, D. P., Geer, W. U., "Critical Masses of Enriched-Uranium Cylinders with Multiple Reflectors of Medium-Z Elements," Nuclear Sci. and Eng. 8, 588-594 (1960). Reported critical masses are not included in this tabulation.

[b] Uncorrected for 0.05 in.^{3} central source cavity

[c] Composition 90 w/o W, 7 w/o Ni, 3 w/o Cu

[d] Corrected for small gap in final configuration

[e] Class A concrete: 1548 lb 3/4" rock, 1563 lb sand, 517 lb Portland cement, 40.3 gal water

[f] Unreflected, m_c = 152.8 (M_{max} = 168); curves of 1/M vs mass paralleled for this series

TABLE IIA1

U(93.3) METAL CYLINDERS DILUTED WITH Fe, Ni, Cu, OR Zn, 15" DIAMETER, UNREFLECTED

Thickness of U(93.3) plates 0.3 cm

Plate of diluent at base, portion of sandwich at top, unless noted otherwise

Average composition is that of final stack

Corrected for influence of supports of split stack

Communicated by G. A. Jarvis

diluent (A)	vol % U(93.3)	repeated layers, thickness (cm) U(93.3)	A	$\bar{\rho}$(U) (g/cm^3)	$\bar{\rho}$(A) (g/cm^3)	h_c (in.)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
Fe	72.8	2.4	0.95	13.28	2.08	4.33	0.289	155.3	151
Fe	62.3	1.5	0.95	11.36	2.88	5.21	0.347	159.9	157
Fe	49.0	0.9	0.95	8.97	3.91	7.02	0.468	170.0	169
Fe	49.0	0.9[a]	0.95	8.97	3.91	7.00	0.467	169.6	163
Fe	39.1	0.6	0.95	7.18	4.68	9.84	0.656	190.8	187
Fe	38.4	0.6[a]	0.95	7.01	4.70	9.96	0.664	188.7	182
Ni	72.4	2.4	0.95	13.15	2.35	4.33	0.288	153.7	151
Ni	61.8	1.5	0.95	11.33	3.29	5.14	0.343	157.5	157
Ni	48.1	0.9	0.95	8.82	4.47	6.82	0.455	162.6	157
Ni	39.1	0.6	0.95	7.28	5.26	9.20	0.614	178.8	175
Ni	38.3	0.6[a]	0.95	7.07	5.34	9.28	0.619	177.3	169
Cu	79.4	3.6	0.95	13.96	1.775	3.85	0.256	150.2	145
Cu	72.3	2.4	0.95	12.56	2.40	4.26	0.284	151.8	145
Cu	66.4	1.8	0.95	12.13	2.92	4.68	0.312	153.4	151
Cu	61.2	1.5	0.95	11.21	3.37	5.06	0.338	153.5	151
Cu	57.4	1.2	0.95	10.50	3.70	5.54	0.369	157.1	151
Cu	50.9	0.9	0.95	9.33	4.28	6.39	0.426	161.1	157
Cu	39.2	0.6	0.95	7.22	5.33	8.33	0.555	162.5	157
Cu	31.8	0.9	1.90	5.93	6.03	10.92	0.728	175.0	169
Zn	38.5	0.6	0.95	7.09	4.32	9.43	0.629	180.7	175

[a] U(93.3) plate at base of stack (sandwiches inverted)

TABLE IIA2

U(93.3) METAL CYLINDERS DILUTED WITH Mo, Ta, OR W, 15" DIAMETER, UNREFLECTED

Thickness of U(93.3) plates 0.3 cm

U plate at base, portion of sandwich at top

Average composition is that of final stack

Corrected for influence of supports of split stack

Communicated by G. A. Jarvis

diluent (A)	vol % U(93.3)	repeated layers, thickness (cm) U(93.3)	A	$\bar{\rho}(U)$ (g/cm^3)	$\bar{\rho}(A)$ (g/cm^3)	h_c (in.)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
Mo	89.2	0.6	0.08	16.18	1.080	3.56	0.238	155.8	151
Mo	79.1	0.3	0.08	15.15	2.09	3.96	0.264	155.1	151
Ta	74.5	0.3	0.1	13.43	4.08	4.43	0.295	160.7	151
Ta	59.4	0.3	0.2	10.77	6.52	5.73	0.382	166.7	157
Ta	49.2	0.3	0.3	8.94	8.16	7.31	0.487	176.5	169
W	73.1	0.3	0.1	13.21	4.92	4.33	0.288	154.4	151
W	57.4	0.3	0.2	10.40	7.83	5.55	0.370	155.8	151
W	47.3	0.3	0.3	8.63	9.72	6.74	0.480	157.2	151
W	40.2	0.3	0.4	7.29	10.99	8.31	0.554	163.7	157
W	35.0	0.3	0.5	6.46	12.15	9.85	0.656	171.9	169
W	30.9	0.3	0.6	5.64	12.80	12.23	0.815	186.5	181

TABLE IIA3

U(93.3) METAL CYLINDERS DILUTED WITH Al, Zr, OR Hf, 15" DIAMETER, UNREFLECTED

Thickness of U(93.3) plates 0.3 cm

U plate at base, portion of sandwich at top

Average composition is that of final stack

Corrected for influence of supports of split stack

Communicated by G. A. Jarvis

diluent (A)	vol % U(93.3)	repeated layers, thickness (cm) U(93.3)	A	$\overline{\rho}(U)$ (g/cm^3)	$\overline{\rho}(A)$ (g/cm^3)	h_c (in.)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
Al	78.6	0.3	0.08	14.20	0.555	4.14	0.276	159.0	157
Al	64.8	0.3	0.16	11.68	0.912	5.22	0.348	164.9	163
Al	55.2	0.3	0.24	9.97	1.166	6.39	0.426	172.2	169
Al	48.0	0.3	0.32	8.70	1.358	7.67	0.512	180.4	175
Al	42.6	0.3	0.40	7.75	1.502	9.23	0.615	193.2	187
Zr	71.3	0.3	0.1	13.18	1.810	4.44	0.296	158.2	157
Zr	56.6	0.3	0.2	10.31	2.70	5.84	0.389	162.5	157
Zr	46.5	0.3	0.3	8.45	3.32	7.42	0.495	169.4	163
Zr	39.6	0.3	0.4	7.18	3.74	9.22	0.614	178.7	175
Hf	97.3	(3.6 / 3.9)[a]	0.1	17.55	0.349	3.27	0.218	155.1	151
Hf	93.4	1.5	0.1	16.80	0.837	3.45	0.230	156.6	151
Hf	85.1	0.6	0.1	15.31	1.904	3.82	0.255	158.1	157
Hf	74.1	0.3	0.1	13.30	3.30	4.48	0.299	161.2	157

[a] The two thicknesses of U alternate in successive sandwiches

TABLE IIB1

U(93.3) - GRAPHITE CYLINDERS, UNREFLECTED

Thickness of U(93.3) plates 0.3 cm

U plate at base, portion of sandwich at top

Average composition is that of final stack

Corrected for influence of supports of split stack

Communicated by G. A. Jarvis

vol % U(93.3)	repeated layers, thickness (cm) U(93.3)	repeated layers, thickness (cm) graphite	$\bar{\rho}(U)$ (g/cm^3)	$\bar{\rho}(C)$ (g/cm^3)	h_c (in.)	h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
15" diameter cylinders:								
86.0	2.4	0.40	15.56	0.222	3.67	0.245	154.5	145
82.2	1.8	0.40	14.78	0.282	3.88	0.258	155.0	145
79.2	1.5	0.40	14.28	0.330	4.00	0.267	154.7	150
75.5	1.2	0.40	13.97	0.399	4.14	0.276	156.3	150
69.7	0.9	0.40	12.70	0.485	4.54	0.303	156.0	145
60.7	0.6	0.40	11.06	0.631	5.23	0.349	156.5	150
53.6	0.9	0.80	9.97	0.758	5.86	0.390	157.7	153
43.5	0.3	0.40	8.07	0.921	7.48	0.499	163.1	157
33.8	0.6	1.20	6.22	1.075	10.24	0.683	172.3	169
28.0	0.3	0.80	5.26	1.188	13.61	0.908	193.6	187
21" diameter cylinders:								
47.7	0.3	0.32	8.94	0.830	5.46	0.260	267	259
31.8	0.3	0.64	5.97	1.123	7.81	0.372	260	247
23.7	0.3	0.95	4.44	1.248	10.48	0.499	258	247
19.00	0.3	1.27	3.56	1.345	13.08	0.623	258	247
15.79	0.3	1.59	2.96	1.392	16.49	0.785	263	259
13.53	0.3	1.90	2.54	1.434	20.1	0.958	274	270
11.89	0.3	2.22	2.23	1.467	23.9	1.138	292	282
10.47	0.3	2.54	1.965	1.540	28.3	1.345	303	294
9.44	0.3	2.86	1.770	1.551	36.4	1.734	350	341
32" square cross section, U(93.2) foil:								
2.93	0.021 av[a]	0.71	0.549	1.602	35.9	-	303	285

[a] Combinations of spaced 0.005", 0.003", 0.002" foil; graphite at base; correction for nearby counters, top and bottom structure

TABLE IIB2a

GRAPHITE-MODERATED HIGHLY-ENRICHED U, REFLECTOR OF GRAPHITE

	core						reflector				
ref	dimensions (in.)	U spec	layer thickness U (total)	layer thickness graphite	$\bar{\rho}$ (U) (g/cm^3)	$\bar{\rho}$ (C) (g/cm^3)	surfaces reflected	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg U^{235})	m_{max} (kg U^{235})
(22)	21.00 dia, h_c/d = 0.112	U(93.3) (47.7 v/o)	0.30 cm	0.32 cm	8.94	0.83	both planes (21.0" dia)	6.00	1.7	112.1[a]	105.8
(22)	21.00 dia, h_c/d = 0.185	U(93.3) (31.8 v/o)	0.30 cm	0.64 cm	5.97	1.12	both planes (21.0" dia)	6.00	1.7	123.3[a]	117.5
(22)	21.00 dia, h_c/d = 0.373	U(93.3) (19.0 v/o)	0.30 cm	1.27 cm	3.56	1.34	both planes (21.0" dia)	6.00	1.7	148.4[a]	141.1
(22)	21.00 dia, h_c/d = 0.64	U(93.3) (13.5 v/o)	0.30 cm	1.91 cm	2.54	1.43	both planes (21.0" dia)	6.00	1.7	182.7[a]	176.3
(22)	21.00 dia, h_c/d = 1.04	U(93.3) (10.47 v/o)	0.30 cm	2.54 cm	1.96	1.54	both planes (21.0" dia)	6.00	1.7	228.5[a]	222.7
(22)	21.00 dia, h_c/d = 1.39	U(93.3) (9.44 v/o)	0.30 cm	2.86 cm	1.77	1.55	both planes (21.0" dia)	6.00	1.7	276.0[a]	258.6
(22)	21.00 dia, h_c/d = 2.10	U(93.3) (8.76 v/o)	0.30 cm	3.18 cm	1.62	1.57	both planes (21.0" dia)	6.00	1.7	377.6[a]	364.4
(21)	10.50 dia, h_c/d = 0.402	U(93.4)	0.63"	0.50"	10.43	0.72	complete	2.00	1.68	58.4[b]	(M_{max} = 29)
(32)	48.0 x 48.0 x 48.0	U(93.2)	0.001"	(C/U^{235} = 7135)		1.50	complete	12.00	1.55	7.44[c]	critical
(32)	48.0 x 39.0 x 42.0	U(93.2)	0.001"	(C/U^{235} = 5297)		1.50	complete	12.00	1.55	7.11[c]	critical
(32)	40.0 x 36.0 x 36.0	U(93.2)	0.001"	(C/U^{235} = 3369)		1.50	complete	12.00	1.55	7.38[c]	critical
(32)	40.0 x 33.0 x 33.0	U(93.2)	0.001"	(C/U^{235} = 2538)		1.50	complete	12.00	1.55	8.24[c]	critical
(32)	48.0 x 48.0 x 45.6[d]	U(93.2)	0.001"	(C/U^{235} = 4685)		1.34	complete	12.00	1.55	9.07[c]	critical
(32)	42.0 x 39.0 x 40.0	U(93.2)	0.001"	(C/U^{235} = 2972)		1.34	complete	12.00	1.55	9.52[c]	critical

[a] No correction for 0.020" thick ss diaphragm across median plane of assembly

[b] Empirical correction for 0.063" ss diaphragm supporting part of assembly

[c] Core and reflector contain 0.061 v/o Al (1100F) as matrix of 3" square tubes

[d] Three extra 3" square tubes are averaged into this dimension of core

TABLE IIB2b

GRAPHITE-MODERATED HIGHLY-ENRICHED U, REFLECTOR OF Be (PLUS SOME GRAPHITE)

Core and reflector contain Al (1100) at $\bar{\rho}$ = 0.165 g/cm^3 as matrix of 3" square tubes; forms are pseudocylinders

One-inch thick unloaded graphite across face 1 of core

Core uranium is U(93.2); $\bar{\rho}$ (Be) = 1.66 g/cm^3

U foil in core 0.002" thick up to 16.3 kg U^{235}, beyond which 0.005" thick foil intermixed

All assemblies critical

	Core			reflector				
				Be thickness (in.)				
ref	dimensions (in.)	C/U^{235}	$\bar{\rho}$ (C) (g/cm^3)	wall	face 1	face 2	graphite thickness against core face 2 (in.)	m_c (kg U^{235})
(33)	24.6 av dia x 30.6	125	1.42	4.88 av	4.00	8.00	0.40	53.6
(33)	24.6 av dia x 30.6	125	1.42	5.39 av	4.00	4.00	0.40	53.6
(33)	31.9 av dia x 31.0	395	1.42	5.10 av	4.50	3.20	0.00	28.7
(33)	36.3 av dia x 31.0	395	1.29	5.51 av	3.00 (1.27" C outside both faces of Be)	3.00	0.00	33.5
(33)	38.4 av dia x 31.0	398	1.30	5.04 av	3.35	3.35	0.00	37.6
(33)	38.4 av dia x 30.0	1022	1.48	4.72 av	3.85	0.00 9.1 C	1.00	16.2
(33)	38.4 av dia x 30.0	1022	1.48	4.72 av	3.85	3.85	1.00	16.2
(34)	55.0 av dia x 52.0	1350	1.17	inside: C, 2.00 av outside: Be, 6.50 av	0.00 (no C on face)	0.00	0.00	32.0

TABLE IIC1

LUCITE MODERATED U(93.16), UNREFLECTED

Al matrix throughout core and as incidental reflector, $\bar{\rho}$ (Al) = 0.165 g/cm^3

Probable error in m_c about ± 1% for critical systems

Communicated by J. C. Hoogterp

thicknesses of alternating layers (in.)	$\bar{\rho}$ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	C/U^{235}	dimensions (in.)	m_c (kg U^{235})	M_{max}
0.012 U, 1/16 lucite	2.12	5.99	3.74	23.5 x 12 x 10.87	106.5	critical
0.012 U, 1/16 lucite	2.31	5.99	3.74	23.5 x 12 x 9.26	98.8	critical
0.006 U, 1/16 lucite	1.317	12.12	7.57	15 x 11.4 x 12	44.2	critical
0.002 U, 1/16 lucite	0.491	35.4	22.1	15 x 12 x 11.46	16.61	critical
0.004 U, 1/8 lucite	0.476	35.6	22.3	15 x 12 x 12	16.83	128
0.008 U, 1/4 lucite	0.477	35.4	22.1	15 x 12 x 12	16.89	critical
0.012 U, 3/8 lucite	0.489	35.3	22.2	15 x 12 x 11.65	16.78	critical
0.016 U, 1/2 lucite	0.484	35.2	22.0	15 x 12 x 12.06	17.22	critical
0.022 U, 11/16 lucite	0.494	35.1	22.0	15 x 12 x 12	17.48	critical
0.030 U, 15/16 lucite	0.495	35.1	22.0	15 x 12 x 12.47	18.22	critical

TABLE IIC2a

LUCITE MODERATED U(93.16), ≥ 6" THICK LUCITE REFLECTOR

Al matrix throughout core and reflector, $\bar{\rho}$ (Al) = 0.165 g/cm^3

Probable error in m_c about ± 1% for critical systems

Communicated by J. C. Hoogterp

core					reflector			
thicknesses of alternating layers (in.)	$\bar{\rho}$ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	av atomic ratio C/U^{235}	critical size (L x H x W-in.)	$\bar{\rho}$ (lucite) (g/cm^3)	thickness/face (L[a] x H x W-in.)	m_c (kg U^{235})	M_{max}
0.006 U, 1/16 lucite	1.311	12.2	7.6	15 x 6 x 8.23	1.007	8.25 x $\binom{6}{9}$ x 9	15.90	critical
0.006 U, 1/16 lucite	1.213	13.3	8.3	15 x 6 x 8	1.048	8,25 x 6 x 6	14.32	critical
0.006 U, 1/16 lucite	1.109	12,1	7.6	15 x 9 x 7.5	1.037	8.25 x 6 x 6	18.41	critical
0.006 U, 1/16 lucite	0.950	12.0	7.5	15 x 9 x 10.5	1.036	8.25 x 6 x 6	22.06	critical
0.002 U, 1/16 lucite	0.363	35.6	22.3	15 x 9 x 10.5	1.036	8.25 x 6 x 6	8.43	critical
0.002 U, 1/16 lucite	0.452	35.3	22.0	15 x 6 x 10.5	1.044	8.25 x 6 x 6	7.00	critical
0.002 U, 1/16 lucite	0.517	34.3	21.5	15 x 6 x 8	1.040	8.25 x 6 x 6	6.10	254
0.004 U, 1/8 lucite	0.518	34.3	21.5	15 x 6 x 8.03	1.040	8.25 x 6 x 6	6.14	725
0.008 U, 1/4 lucite	0.518	34.3	21.4	15 x 6 x 8.10	1.048	8.25 x 6 x 6	6.19	critical
0.012 U, 3/8 lucite	0.518	34.3	21.5	15 x 6 x 8.13	1.048	8.25 x 6 x 6.12	6.21	critical
0.016 U, 1/2 lucite	0.521	34.3	21.5	15 x 6 x 8.39	1.050	8.25 x 6 x 6.06	6.45	critical
0.024 U, 3/4 lucite	0.532	33.5	20.9	15 x 6 x 9.11	1.035	8.25 x 6 x 6.06	7.14	critical
0.030 U, 15/16 lucite	0.509	35.3	22.0	15 x 6 x 10.26	1.031	8.25 x 6 x 6.09	7.70	critical
0.030 U, 13/16 lucite	0.582	30.6	19.1	15 x 6 x 9.48	1.031	8.25 x 6 x 6.26	8.13	519
0.030 U, 11/16 lucite	0.685	26.0	16.2	15 x 6 x 8.04	1.030	8.25 x 6 x 6.98	8.12	893
0.030 U, 9/16 lucite	0.818	21,2	13.2	15 x 6 x 8.34	1.031	8.25 x 6 x 6.83	10.06	critical
0.030 U, 7/16 lucite	1.021	16.6	10.4	15 x 6 x 7.89	1.030	8.25 x 6 x 7.05	11.89	170
0.008 U, 15/16 lucite	0.138	133.3	83.2	15 x 6 x 17.09	1.001	8.25 x 6 x 6.04	3.47	critical
0.008 U, 11/16 lucite	0.186	97.8	61.1	15 x 6 x 12.35	1.000	8.25 x 6 x 8.33	3.38	critical
0.008 U, 9/16 lucite	0.229	79.4	49.6	15 x 6 x 10.79	1.000	8.25 x 6 x 9.11	3.65	28

[a] Reflector thickness on ends averaged to allow for 1/2" irregularity

TABLE IIC2b

LUCITE MODERATED U(93.16) SLABS, 6" THICK LUCITE REFLECTORS ON TWO LARGE SURFACES ONLY

Alternating layers of 0.002" U and 1/16" lucite in core

Al matrix throughout core and reflector, $\bar{\rho}$ (Al) = 0.165 g/cm^3

Probable error in m_c about ± 1% for critical systems

Communicated by J. C. Hoogterp

core				reflector		
$\bar{\rho}$ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	av atomic ratio C/U^{235}	dimensions (in.)	$\bar{\rho}$ (lucite) (g/cm^3)	m_c (kg U^{235})	M_{max}
0.488	35.3	22.1	15[a] x 6 x 14.53	0.977	10.45	2320
0.422	36.0	22.5	32 x 6 x 13.06	1.007	17.34	critical
0.372	35.7	22.3	32 x 6 x 17.03	1.006	19.96	2320
0.478	36.0	22.5	32 x 5.24 x 12	1.022	15.79	102
0.491	35.9	22.4	32 x 5 x 12	1.022	15.44	1821
0.479	37.3	23.3	32 x 3 x 23.03	1.041	17.37	critical
0.479	35.6	22.2	32 x 3 x 28.5	1.002	21.5	critical
0.431	35.7	22.3	32 x 3 x 54	1.041	36.6	critical
0.474	36.2	22.6	32 x 2.71 x 48	1.040	32.4	187
0.473	36.1	22.6	32 x 2.69 x 52.8	1.037	35.2	critical
0.498	36.2	22.6	32 x 2.50 x 58.9	1.041	38.5	38.6

[a] Reflector overhangs fuel 1/2" on both sides

TABLE IID1

LUCITE-GRAPHITE MODERATED U(93.16), UNREFLECTED

Lucite thickness 1/16" per indicated thicknesses of U and graphite

Al matrix throughout core and as incidental reflector, $\overline{\rho}$ (Al) = 0.165 g/cm^3

Probable error in m_c about ± 1% for critical systems

Communicated by J. C. Hoogterp

thicknesses of layers with 1/16" lucite (in.)	$\overline{\rho}$ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	av atomic ratio C/U^{235}	dimensions (in.)	m_c (kg U^{235})	M_{max}
0.012 U, 0.120 graphite	0.916	6.02	24.1	23.5 x 18.14 x 18	115.2	critical
0.012 U, 0.280 graphite	0.518	6.04	48.7	23.5 x 28.02 x 24	134.2	317
0.006 U, 0.280 graphite	0.258	12.41	98.2	32 x 24.70 x 24.70	82.4	critical
0.006 U, 0.280 graphite	0.258	12.41	98.2	32 x 13.61 av radius[a]	78.6	critical
0.006 U, 0.280 graphite	0.258	12.27	98.7	23.5 x 28.5 x 28.79	81.4	critical
0.002 U, 0.120 graphite	0.337	35.2	51.8	15 x 15 x 15.69	19.51	critical
0.002 U, 0.120 graphite	0.337	35.2	48.2	15 x 15 x 16.69	20.7	critical
0.002 U, 0.280 graphite	0.224	35.0	101.5	15 x 21 x 21	24.2	critical

[a] Pseudocylinder with 3" module

TABLE IID2a

LUCITE-GRAPHITE MODERATED U(93.16), LUCITE REFLECTED

U thickness 0.006" and lucite thickness 1/16" per indicated thickness of graphite in core

Al matrix throughout core and reflector, $\bar{\rho}$ (Al) = 0.165 g/cm^3

All systems critical, probable error in m_c about ± 1%

Communicated by J. C. Hoogterp

	core				reflector			
graphite thickness (in.) per 0.006" U, 1/16" lucite	$\bar{\rho}$ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	av atomic ratio C/U^{235}	critical size (L x H x W-in.)	$\bar{\rho}$ (lucite) (g/cm^3) ends	$\bar{\rho}$ (lucite) (g/cm^3) sides	thickness/face (L[a] x H x W-in.)	m_c (kg U^{235})
0.280	0.255	12.46	100.3	23.5 x 24 x 24	1.021	0.938	~6 x 1.50 x 1.50	43.2
0.280	0.223	12.48	100.6	23.5 x 21 x 21	1.021	0.969	~6 x 4 x 4	37.8
0.280	0.252	12.12	101.2	23.5 x 18 x 18	1.042	0.984	~6 x 3.75 x 3.75	31.5
0.280	0.244	12.12	101.2	23.5 x 18 x 18	1.042	1.021	~6 x 7.50 x 7.50	30.5
0.280	0.252	12.05	101.5	23.5 x 17.25 x 17.4	1.042	0.982	~6 x 6.38 x 6.32	29.0
0.280	0.251	12.10	101.6	23.5 x 9.57 av radius[b]	1.042	0.980	~6 x 7.10 av[b]	27.8
0.004 av[c]	0.934	12.05	8.89	15 x 9 x 10.5	1.036	1.036	8.25 x 6 x 6	21.7

[a] Low-density 1.5" extension of 6" thick reflector; 8.25" end reflector thickness is averaged over 1/2" irregularity

[b] Pseudocylinder with 3" module

[c] Average of nonuniformly-distributed 0.120"-thick graphite

TABLE IID2b

LUCITE-GRAPHITE MODERATED U(93.16) SLABS, 6" THICK LUCITE REFLECTORS ON TWO LARGE SURFACES ONLY

Core consists of the successive layers: 0.006" U, 1/16" lucite, 0.280" graphite

Al matrix throughout core and reflector, $\bar{\rho}$ (Al) = 0.165 g/cm^3

All systems critical, probable error in m_c about ± 1%

Communicated by J. C. Hoogterp

core				reflector	
ρ (U^{235}) (g/cm^3)	av atomic ratio H/U^{235}	av atomic ratio C/U^{235}	dimensions (in.)	$\bar{\rho}$ (lucite) (g/cm^3)	m_c (kg U^{235})
0.239	13.0	106.2	32 x 13.5 x 29.8	1.001	50.4
0.239	13.2	105.4	32 x 12 x 35.4	1.032	53.3
0.239	13.2	106.9	32 x 9 x 110	1.029	124.0
0.254	12.4	99.1	64 x 9 x 39.1	1.042	93.8
0.254	12.5	99.2	64 x 8.25 x 52.6	1.033	115.9

TABLE IIE1

DIFFUSE U(93.1) REFLECTED BY THICK D_2O OR Be (CAVITY ASSEMBLIES)

U^{235} enrichment of all uranium is 93.15 w/o

ref	core: cavity cylinder dimensions (in.)	core: fuel	cylindric reflector: material	cylindric reflector: thickness (in.)	cylindric reflector: interior liner	m_c (kg U^{235})	M_{max}
(35)	40 dia x 40	0.003" U foil covering cavity surface, on av 0.05" Al support	D_2O (99.2 w/o)	20	1/8" Al, av	6.00[a]	critical
(35)	same except 4" dia axial channel through bottom reflector					6.06	critical
(35)	same except 6" dia axial channel through bottom reflector					6.09	critical
(35)	same except 8" dia axial channel through bottom reflector					6.19	critical
(35)	same except 9" dia axial channel through bottom reflector					6.26	critical
(35)	same except 10" dia axial channel through bottom reflector					6.40	critical
(35)	same except 23.9 kg D_2O (12" x 12" cyl) at cavity center (no channel)					5.60[b]	critical
(35)	40 dia x 40	six 40" discs of 0.035" av U foil 6" apart along cavity axis, on 1/16" Al plates	D_2O (99.2 w/o)	20	1/8" Al, av	7.97[c]	critical
(36)	15-1/2 dia x 31	0.022" av U foil covering cavity surface, on 1/16" Al support	Be ($\bar{\rho}$ = 1.77 g/cm^3)	14 wall, 16 top, 15 bottom	-	11.0[d]	56
(36)	15-1/2 dia x 31	0.015" av U foil covering cavity surface, on 1/16" Al support	Be ($\bar{\rho}$ = 1.79 g/cm^3)	16.5 wall, 16 top, 15 bottom	-	7.7[e]	100
(36)	15-1/2 dia x 31	0.6 o.d., 0.25 i.d. graphite - 22 w/o U rods, distributed uniformly within cavity, parallel to axis	Be ($\bar{\rho}$ = 1.79 g/cm^3)	16.5 wall, 16 top, 15 bottom	1/16" Al	7.6[e,f]	130
(36)	15-1/2 dia x 16	0.6 o.d., 0.25 i.d. graphite - 22 w/o U rods, distributed uniformly within cavity, parallel to axis	Be ($\bar{\rho}$ = 1.77 g/cm^3)	14 wall, 16 top, 30 bottom	1/16" Al	9.9[g]	136

[a] After correction for Al cavity liner and fuel support, m_c = 5.33 kg; 6.93 kg of 0.003" foil covers the cavity completely

[b] Corrected for effect of Al container for central D_2O

[c] After correction for Al cavity liner and fuel support, m_c ~7.0 kg

[d] Corrected (-0.04 kg) for Al fuel support

[e] Corrected (-0.03 kg) for Al cavity liner

[f] m_c = 7.30 kg when fuel concentrated toward outside of cavity, m_c = 8.60 kg when fuel concentrated along axis; with 14" reflector wall, m_c = 6.99 kg when fuel concentrated toward outside of cavity

[g] Corrected (-0.02 kg) for Al cavity liner

TABLE IIE2

$U(93.65)O_2F_2-D_2O$ SOLUTIONS, BARE, D_2O OR GRAPHITE REFLECTED

All systems critical

ref	core: ρ (U^{235}) (g/cm^3)	core: atomic ratio D/U^{235}	core: shape	core: solution dimensions (in.)	core: container	reflector: shape	reflector: dimensions (in.)	reflector: composition	m_c (kg U^{235})
(37)	0.1094	230[a]	cylinder	24.9 dia x 28.1	1/8" ss		none		24.5
	1" o.d. x 7/8" i.d. ss "dry" axial glory hole								
(37)	0.0610	419[a]	cylinder	24.9 dia x 31.0	1/8" ss		none		15.04
	1" o.d. x 7/8" i.d. ss "dry" axial glory hole								
(37)	0.0301	856[a]	cylinder	30.0 dia x 24.1	1/8" ss		none		8.37
	1" o.d. x 7/8" i.d. ss "dry" axial glory hole								
(37)	0.0301	856[a]	cylinder	30.0 dia x 24.0	1/8" ss		none		8.33
	1-1/8" o.d. x 1" i.d. Al "dry" axial glory hole								
(37)	0.0124	2081[a]	cylinder	30.0 dia x 33.4	1/8" ss		none		4.78
	1-1/8" o.d. x 1" i.d. Al "dry" axial glory hole								
(37)	0.679	34.2[b]	sphere	~13.5 dia	0.04" ss (321)	sphere[c]	10.7 thick D_2O	~99.5% D_2O	14.19
(37)	0.443	53.7[b]	sphere	~14.5 dia	0.04" ss (321)	sphere[c]	10.2 thick D_2O	~99.5% D_2O	11.56
(37)	0.302	81.2[b]	sphere	~15.5 dia	0.04" ss (321)	sphere[c]	9.7 thick D_2O	~99.5% D_2O	9.57
(37)	0.185	135.3[b]	sphere	~16.5 dia	0.04" ss (321)	sphere[c]	9.2 thick D_2O	~99.5% D_2O	7.05
(37)	0.104	243[b]	sphere	~17.5 dia	0.04" ss (321)	sphere[c]	8.7 thick D_2O	~99.5% D_2O	4.77
(37)	0.0595	431[b]	sphere	~18.5 dia	0.04" ss (321)	sphere[c]	8.2 thick D_2O	~99.5% D_2O	3.20
(38)	1.051	19.56[a]	cylinder	12.5 dia x 12.1	ss, 1/16" wall, 1/8" top, bottom	cylinder	32 dia x 31.75 9.67 wall, 10 base, 8.5 top	graphite (CS-312) ρ = 1.67 g/cm^3	25.51
	0.9" thick space above solution								
(38)	0.595	39.4[a]	cylinder	14 dia x 13.4	ss, 1/16" wall, 1/8" top, bottom	cylinder	32 dia x 31.75 8.92 wall, 10 base, 7 top	graphite (CS-312) ρ = 1.67 g/cm^3	20.11
	1.1" thick space above solution								

[a] No correction for ~1 mole percent H_2O

[b] No correction for ~0.3 mole percent H_2O

[c] Stainless steel container 35" i.d., ~0.1" thick

TABLE IIF1a

$U(14.67)O_2SO_4-H_2O$ SOLUTION, SPHERE

Solution volume 14.95 liters, container 12" dia, 1/32" thick, type 347 ss sphere

	critical core		reflector					
reference	ρ (U^{235}) (g/cm^3)	atomic ratio H/U^{235}	material	ρ (g/cm^3)	shape	outside dimension (in.)	m_c (kg U^{235})	m_{max} (kg U^{235})
(39)	0.0378	647	BeO supported on ~12" thick graphite plate	2.7	pseudosphere	~36 dia	0.565_5	critical
(39)	0.0383	638	BeO supported on ~12" thick graphite plate	2.7	pseudosphere	~36 dia	0.572 ± 2[a]	critical
(39)	0.0383	638	BeO (inside) graphite	2.7 1.67	cube cube	24 18 thick	0.573 ± 2[a]	critical
(39)	0.0492	497	graphite (inside) BeO	1.67 2.7	cube cube	18 12 thick	0.735 ± 10[a]	0.66
(39)	0.0508	481	graphite	1.67	cube	48	0.760 ± 10[a]	0.66
(39),(40)	0.0803	~300	water	1.0	cylinder	60 dia x 60	1.20 ± 0.05[a]	0.72[b]

[a] Large detector displacing reflector near core, re-entrant tube in core

[b] Although this measurement does not satisfy the criterion $m_{max}/m_c \geq 0.75$, multiplication curves with several detector types and locations lead to greater reliability than usual

TABLE IIF1b

U(93.5)-PHOSPHATE AQUEOUS SOLUTION, CYLINDERS, 3.0" THICK Fe REFLECTOR[a]

Solutions of UO_3 dissolved in 4.26 molar H_3PO_4

Solution cylinder 12.4" dia; 1/8" ss (347) container included in thickness of mild steel reflector

reference	ρ (U^{235}) of solution (g/cm^3)	atomic ratio H/U^{235}	$\bar{\rho}$ (347 ss) in core (g/cm^3)[b]	solution h_c (in.)	core h_c/d	m_c (kg U^{235})	m_{max} (kg U^{235})
(41),(42)	0.112	212	0	6.5	0.52	1.43 ± 0.02	1.35
(42)	0.112	212	0.725	10.0	0.81	2.02 ± 0.02	1.93
(42)	0.112	212	1.140	17.1	1.38	3.26 ± 0.03	3.10
(41),(42)	0.101	235	0	6.8	0.55	1.36 ± 0.02	1.27
(42)	0.101	235	0.725	10.8	0.87	1.97 ± 0.02	1.85
(41),(42)	0.090	265	0	7.1	0.57	1.25 ± 0.02	1.23
(42)	0.090	265	0.725	12.1	0.97	1.95 ± 0.04	1.85
(41),(42)	0.075	321	0	7.7	0.62	1.14 ± 0.02	1.10
(42)	0.075	321	0.725	15.6	1.26	$2.10 \pm ^{0.12}_{0.03}$	1.83

[a] Reflector nearly in contact with top of solution

[b] Plates of 1/16" thick type 347 stainless steel distributed throughout the solution as vertical grids

TABLE IIF2

ENRICHED-URANIUM HYDRIDE COMPOSITION[a]

Cores are homogeneous except that of last entry

	core			reflector					
ref	effective composition	$\bar{\rho}$ (U^{235}) (g/cm^3)	shape[b]	material	ρ (g/cm^3)	shape	thickness (in.)	m_c (kg U^{235})	M_{max}
(43)	$U(93.15)H_{2.97}C_{1.11}O_{.25}$	6.36	pseudosphere	U(N)	19.0	pseudosphere	~8-1/2	12.61	critical
(43)	$U(93.15)H_{2.97}C_{1.11}O_{.25}$	6.36	pseudosphere	Ni	8.8	pseudosphere	~8-1/2	12.63	critical
(43)	$U(93.15)H_{2.97}C_{1.11}O_{.25}$	6.36	pseudosphere	Ni (inside) U(N)	8.8 19.0	pseudosphere pseudosphere	~1/2 ~8	11.81	critical
(43)	$U(93.15)H_{2.97}C_{1.11}O_{.25}$	6.36	pseudosphere	Ni (inside) U(N)	8.8 19.0	pseudosphere pseudosphere	~1 ~7-1/2	11.64	critical
(43)	$U(93.15)H_{2.97}C_{1.11}O_{.25}$	6.36	approx. cube	U(N)	19.0	pseudosphere	~8-1/2	12.98	critical
(44)	$U(73.8)H_{10}C_4$	2.09	pseudoellipsoid	U(N)	18.6	sphere	~6-1/2	6.95 ± 0.12	critical
(44)	$U(75.0)H_{10}C_4$	2.17	pseudosphere	WC	~14.7	cube	~4-1/2	7.00 ± 0.05	critical
(44)	$U(75.0)H_{10}C_4$	2.17	approx. cube	WC	~14.7	cube	~4-1/2	7.53 ± 0.12	critical
(44)	$U(73.5)H_{10}C_4$	2.06	pseudoellipsoid	Pb	11.2	sphere	~6-1/2	9.2 ± 0.2	14.5
(44)	$U(73.5)H_{10}C_4$	2.06	pseudoellipsoid	Fe	7.8	sphere	~6-1/2	8.29 ± 0.17	critical
(44)	$U(75.2)H_{10}C_4$	2.18	approx. cube	BeO	2.69	cube	~6	3.52 ± 0.05	critical
(44)	$U(75.2)H_{10}C_4$	2.18	approx. cube	BeO	2.69	cube	~12	2.80 ± 0.06	critical
(44)	$U(73.8)H_{10}C_4$	2.07	approx. cube		none			16.5 ± 1.2	13.7
(45)	av $U(94.5)H_{3.8}C_{1.9}$[c] (heterogeneous)	5.32	pseudosphere	U(N)	19.0	pseudosphere	~8	11.35	critical

[a] Heterogeneous mixtures of $U(72)H_{10}C_4$ and polyethylene extending to the average composition $UH_{80}C_{39}$ have not been tabulated because of imperfect reflector assemblies and deficient core densities

[b] All cores built of 1/2" cubic units

[c] Core composed of 1/2" cubes of U(94.5) metal and of polyethylene, intermixed to average 30 v/o U

TABLE IIF3

LATTICES OF U(94) METAL UNITS, H_2O MODERATED, H_2O REFLECTED

Centered in water cylinder, 35-1/2" dia x 23" deep

Reference (46)

U^{235} enrichment, w/o	dimensions of metal unit (in.)	lattice structure	lattice form	center-center spacing (in.)	critical no. of units	m_c (kg U^{235})	m_{max} (kg U^{235})	M_{max}
94.0	4.0 x 4.0 x 4.5	(solid core)		-	1	22.5	20.8	110
94.3	1 cube	cubic	approx. cube	1.25	83.4	24.1	22.0	100
94.3	1 cube	cubic	approx. cube	1.50	75.0	21.7	18.5	58
94.3	1 cube	cubic	approx. cube	1.75	73.0	21.1	18.5	81
94.3	1 cube	cubic	approx. cube	2.00	79.9	23.1	19.7	74
94.52	1/2 cube	cubic	approx. cube	0.75	469	17.0	12.4	22
94.52	1/2 cube	cubic	approx. cube	1.00	378	13.7	12.4	90
94.52	1/2 cube	cubic	approx. cube	1.17	372	13.5	12.4	124
94.52	1/2 cube	cubic	approx. cube	1.50	522	18.9	12.4	34
94.52	1/2 cube	body-center cubic	approx. cube	1.50 in any horiz. plane	368	13.3[a]	12.4	143
93.61	1/8 dia x 12 rod	square	pseudocylinder	0.50	171	7.13	6.55	86
93.61	1/8 dia x 12 rod	square	pseudocylinder	0.625	149	6.22[b]	5.91	125
93.61	1/8 dia x 12 rod	square	pseudocylinder	0.750	152	6.33	6.01	170
93.61	1/8 dia x 12 rod	square	pseudocylinder	0.875	173	7.21	6.55	139
93.61	1/8 dia x 12 rod	square	pseudocylinder	1.00	>203	>8.4	6.55	52

[a] With alternate horizontal planes of cubes translated 3/4" to vertical face-center positions, m_c = 13.6 kg

[b] Non uniform arrays of 1/8" rods gave minimum observed m_c = 6.08 kg with spacing graded from 1/2" near axis to 1" near periphery

TABLE IIIA1

PLUTONIUM-METAL SPHERES

Hemispheres of Pu(1.0w/o Ga) are coated with ~0.005" thick Ni, unless otherwise noted

	core		reflector					
ref	w/o Pu^{240}	$\bar{\rho}$ (total Pu) (g/cm^3)	material	shape	thickness (in.)	$\bar{\rho}$ (g/cm^3)	m_c (kg Pu)	M_{max}
(47)	4.5	15.66		none			16.28 ± 0.05[a]	critical
(47)	1.5	15.63	U(N)	pseudosphere	9-1/2 av	19.0	5.73 ± 0.02[b]	critical
(7)	4.8	15.36	U(N)	sphere	7.72	19.0	5.91 ± 0.02[b]	critical
(2)	1.35	15.58	U(N)	sphere	4.60	19.0	6.22	94
(48)	4.9	15.62	U(N)	sphere	1.625 ± 1%	18.92	8.39	$m_{max} > m_c$ [c]
(49)	4.5	15.25	Th	cylinder (21" dia x 21")	8.4 min	11.9	9.24[a]	critical
(48)	4.9	15.62	W[d]	sphere	1.850 ± 1%	17.21	8.39	$m_{max} > m_c$ [c]
(50)	1.35	15.58	Cu	sphere	5.00	8.88	6.88[e]	25
(19)	4.9	15.74	Al (2014)	sphere	3.12 ± 0.03	2.82	11.04	$m_{max} > m_c$ [c]
(48)	4.9	15.62	Be (98 w/o)	sphere	1.452 ± 1%	1.83	8.39	$m_{max} > m_c$ [c]
(25)	1.35	15.58	water	cylinder	>12	1.00	7.9[f]	15
(10)	1.0	15.6	inside: U(N) outside: Al	sphere sphere	(9.0 o.d.) (18.5 o.d.)	19.0 2.7	6.46[f]	m_{max} = 6.15
(10)	1.35	15.58	inside: U(N) outside: WC	sphere parallelepiped (12.75" x 12.75" x 10.62")	0.45	19.0 ~14.7	6.13[f]	critical

[a] Three major parts; corrected empirically for effect of Ni, cavities, incidental reflection and asphericity

[b] Corrected empirically for effect of Ni and cavities

[c] Effect of a small compensating gap was extrapolated to zero

[d] Composition 91.3 w/o W, 5.5 w/o Ni, 2.5 w/o Cu, 0.7 w/o Zr

[e] No correction for 0.41" central source cavity

[f] No correction for 0.83" central source cavity

TABLE IIIA2

PLUTONIUM-METAL CYLINDERS

Cores of Pu(1w/o Ga) containing ~5% Pu^{240}; no correction for Ni coating

Reference (12)

See also the last item of Table VB

core			cylindric reflector				
cylinder dia (in.)	h_c/d	$\bar{\rho}$ (total Pu) (g/cm^3)	material	$\bar{\rho}$ (g/cm^3)	thickness (in.)	m_c (kg Pu)	m_{max} (kg Pu)
2.25[a]	8.75	15.44	U(~0.3)[b]	18.7	3.0	20.0 ± 0.1	19.2
2.25[a]	7.13	15.44	graphite[b]	1.60	7.0	16.3 ± 0.1	15.7
2.21[a]	12.52	15.44	water	1.00	>12	27.1 ± 1.5	21.3
6.0[c]	0.258	14.3	U(N)	18.7	3.0	10.14 ± 0.07	9.9
6.0[c]	0.390	14.3	graphite	1.60	1.0	15.44 ± 0.07	15.4
6.0[c]	0.273	14.3	graphite	1.60	7.0	10.8 ± 0.07	10.7
6.0[c]	0.280	14.3	water[d]	1.00	>12	11.1 ± 0.2	9.9
11.0[c,e]	0.095	13.1[e]	water[d]	1.00	>12	21.4 ± 0.8	20.0
16.0[c,e]	0.049	13.1[e]	water[d]	1.00	>12	34.1 ± 1.2	26.5

[a] Pu pieces 0.5" to 3.0" thick, each coated with 0.005" thick Ni

[b] Reflector wall lined with 0.030" thick steel

[c] Pu pieces 5.934" dia x 0.123" in thin Ni cans with outside dimensions 5.967" x 0.135"

[d] Core sealed in lucite container before immersion in water

[e] Average diameter and density of cylinders constructed of overlapping layers of close-packed plates

TABLE IIIB1

DILUTED Pu CYLINDERS, 6.0" DIAMETER, UNREFLECTED

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135", ρ (Pu) = 15.61 g/cm^3.

Diluent plates 5.967" dia x 1/8" or 1/4"

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.)		core-average ρ (g/cm^3)[a]			h_c (in.)	h_c/d[a]	m_c (kg Pu)	m_{max} (kg Pu)
		Pu	A	$\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)				
none	91.4	1/8	-	14.27	-	0.65	3.23	0.54	21.4[b]	20.2
U(0.28)	63.0	1/4	1/8	9.83	5.97	0.45	6.07	1.01	27.3	25.2
steel[c]	62.7	1/4	1/8	9.78	2.50	0.45	7.32	1.22	32.8	27.1
Th	62.7	1/4	1/8	9.78	3.62	0.45	7.85	1.31	35.2	27.1

[a] Based on 6.00" diameter

[b] Also reported in (51) are reflector saving values for 1/2" thick discs of polyethylene, Be, graphite, Mg, Al, Ti, Fe, Co, Ni, Cu, Mo, W, Th, U(N), and U(0.28), on the top of this Pu stack

[c] Stainless steel, type 304

TABLE IIIB2

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 2.0" THICK U(~0.3) REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve, 0.030" thick, within reflector cylinder; $\bar{\rho}$ (U) = 19.0

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.)		core-average ρ $(g/cm^3)^a$			h_c (in.)	h_c/d^a	m_c (kg Pu)	m_{max} (kg Pu)
		Pu	A	$\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)				
none	90.8	1/8	-	14.18	-	0.65	1.72	0.29	11.1_5	10.7
U(0.28)	62.2	1/4	1/8	9.71	5.95	0.45	2.92	0.49	13.0	12.5
steel[b]	62.5	1/4	1/8	9.75	2.51	0.45	3.15	0.52_5	14.1	13.9
Th	62.4	1/4	1/8	9.74	3.63	0.45	3.29	0.55	14.7	14.4
Al[c]	62.3	1/4	1/8	9.72	0.84	0.45	3.23	0.54	14.4	14.15
space	64.0	1/4	1/8	9.97	-	0.45	3.29	0.55	15.0_5	14.4
U(0.28)	47.8	1/8	1/8	7.46	9.03	0.34	4.56	0.76	15.6	15.4
steel[b]	47.6	1/8	1/8	7.43	3.78	0.34	5.58	0.93	19.0	18.7
Th	48.0	1/8	1/8	7.49	5.55	0.34	6.02	1.00	20.6_5	19.8
Al[c]	48.0	1/8	1/8	7.49	1.28	0.34	5.78	0.96	19.9	19.6
space	48.7	1/8	1/8	7.60	-	0.35	6.43	1.07	22.4	21.7
U(0.28)	32.4	1/8	1/4	5.05	12.22	0.23	12.49	2.08	28.9	27.1

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IIIB3

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 4.5" THICK U(~0.3) REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve, 0.030" thick, within reflector cylinder; $\bar{\rho}$ (U) = 19.0

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.) Pu	A	core-average ρ (g/cm^3)[a] $\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)	h_c (in.)	h_c/d[a]	m_c (kg Pu)	m_{max} (kg Pu)
none	91.4	1/8	-	14.26	-	0.65	1.42	0.24	9.3	9.0
U(0.28)	61.8	1/4	1/8	9.65	5.88	0.44	2.40	0.40	10.6	9.0
steel[b]	60.6	1/4	1/8	9.46	2.48	0.44	2.59	0.43	11.2	10.6
Th	62.5	1/4	1/8	9.75	3.65	0.45	2.62	0.44	11.7	10.8
Al[c]	62.5	1/4	1/8	9.75	0.84	0.45	2.58	0.43	11.5_5	10.8
space	63.7	1/4	1/8	9.95	-	0.45	2.59	0.43	11.8	10.8
U(0.28)	47.5	1/8	1/8	7.42	9.08	0.34	3.72	0.62	12.6_5	12.55
steel[b]	47.5	1/8	1/8	7.42	3.81	0.34	4.26	0.71	14.5	14.35
Th	47.7	1/8	1/8	7.44	5.55	0.34	4.51	0.75	15.4	15.2
Al[c]	47.5	1/8	1/8	7.42	1.27	0.34	4.34	0.72	14.8	14.35
space	49.0	1/8	1/8	7.65	-	0.35	4.46	0.74	15.7	15.4
U(0.28)	32.4	1/8	1/4	5.06	12.28	0.23	7.99	1.33	18.5_5	18.0
steel[b]	32.3	1/8	1/4	5.04	5.14	0.23	10.97	1.83	25.3	24.3
Th	32.5	1/8	1/4	5.07	7.70	0.23	12.90	2.15	30.0	28.0
Al[c]	32.4	1/8	1/4	5.05	1.75	0.23	11.42	1.90	26.4	26.1
space	32.7	1/8	1/4	5.11	-	0.23	12.84	2.14	30.1	27.0

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IIIB4

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 7.5" THICK U(~0.3) REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve 0.030" thick, within reflector cylinder; $\bar{\rho}$ (U) = 19.0

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.) Pu	A	core-average ρ (g/cm^3)[a] $\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)	h_c (in.)	h_c/d[a]	m_c (kg Pu)	m_{max} (kg Pu)
none	91.2	1/8	-	14.23	-	0.65	1.37	0.23	8.9_5	8.0
U(0.28)	62.6	1/4	1/8	9.77	5.94	0.45	2.31	0.38_5	10.3_5	10.3
steel[b]	62.5	1/4	1/8	9.76	2.51	0.45	2.43	0.40_5	10.9	10.8
Th	62.5	1/4	1/8	9.76	3.63	0.45	2.49	0.41_5	11.1	10.8
Al[c]	62.5	1/4	1/8	9.76	0.84	0.45	2.47	0.41	11.0_5	10.8
space	63.5	1/4	1/8	9.92	-	0.45	2.47	0.41	11.2_5	10.8
U(0.28)	47.7	1/8	1/8	7.44	9.05	0.34	3.51	0.58_5	11.9_5	11.7
steel[b]	47.7	1/8	1/8	7.45	3.80	0.34	3.97	0.66_5	13.5_5	13.3
Th	48.1	1/8	1/8	7.51	5.57	0.34	4.14	0.69	14.2_5	14.2
Al[c]	48.0	1/8	1/8	7.50	1.28	0.34	3.98	0.66_5	13.7	13.5
space	48.8	1/8	1/8	7.62	-	0.35	4.18	0.70	14.6	14.4
U(0.28)	32.4	1/8	1/4	5.06	12.27	0.23	7.29	1.22	16.9	16.7
steel[b]	32.1	1/8	1/4	5.01	5.11	0.23	9.49	1.58	21.8	21.7
Th	32.5	1/8	1/4	5.07	7.49	0.23	10.83	1.80	25.1_5	25.0
Al[c]	32.4	1/8	1/4	5.05	1.75	0.23	9.65	1.61	22.3_5	22.3
space	32.8	1/8	1/4	5.12	-	0.23	10.58	1.76	24.8_5	24.4
U(0.28)	24.4	1/8	3/8	3.81	13.87	0.17	17.24	2.87	30.1	27.0

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IIIB5

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 2.0" THICK Th REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve, 0.030" thick, within reflector cylinder; $\bar{\rho}$ (Th) = 11.9 g/cm^3

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.)		core-average ρ $(g/cm^3)^a$			h_c (in.)	h_c/d^a	m_c (kg Pu)	m_{max} (kg Pu)
		Pu	A	$\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)				
none	91.3	1/8	-	14.25	-	0.65	2.25	0.37_5	14.7	14.5
U(0.28)	63.1	1/4	1/8	9.85	5.29	0.45	3.90	0.65	17.6	16.3
steel[b]	62.8	1/4	1/8	9.81	2.51	0.45	4.32	0.72	19.4	18.1
Th	62.8	1/4	1/8	9.81	3.63	0.45	4.44	0.74	20.0	18.1
Al[c]	62.8	1/4	1/8	9.81	0.84	0.45	4.46	0.74	20.0_5	18.1
space	64.0	1/4	1/8	9.99	-	0.45	4.80	0.80	22.0	19.9
U(0.28)	47.5	1/8	1/8	7.41	9.01	0.34	6.55	1.09	22.2_5	21.65
steel[b]	50.4	1/8	1/8	7.87	4.01	0.36	8.50	1.42	30.6	26.1
Th	47.9	1/8	1/8	7.48	5.54	0.34	9.78	1.63	33.5	26.1
Al[c]	48.1	1/8	1/8	7.51	1.29	0.34	10.15	1.69	34.9	26.1

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IIIB6

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 4.5" THICK Th REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve, 0.030" thick, within reflector cylinder; $\bar{\rho}$ (Th) = 11.9 g/cm^3

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.) Pu	A	core-average ρ $(g/cm^3)^a$ $\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)	h_c (in.)	h_c/d^a	m_c (kg Pu)	m_{max} (kg Pu)
none	91.8	1/8	-	14.33	-	0.66	2.02	0.34	13.2_5	12.6
U(0.28)	62.5	1/4	1/8	9.75	5.94	0.45	3.42	0.57	15.3	14.4
steel[b]	63.1	1/4	1/8	9.85	2.52	0.45	3.74	0.62_5	16.9	16.2
Th	63.0	1/4	1/8	9.83	3.67	0.45	3.90	0.65	17.5_5	16.2
Al[c]	63.1	1/4	1/8	9.85	0.84	0.45	3.88	0.64_5	17.5	16.2
space	63.9	1/4	1/8	9.97	-	0.45	3.99	0.66_5	18.2	16.2
U(0.28)	47.7	1/8	1/8	7.45	9.06	0.34	5.52	0.92	18.9	18.0
steel[b]	47.3	1/8	1/8	7.39	3.77	0.34	6.85	1.14	23.5	22.5
Th	47.9	1/8	1/8	7.47	5.52	0.34	7.35	1.22_5	25.2	24.4
Al[c]	47.8	1/8	1/8	7.46	1.28	0.34	7.35	1.22_5	25.1_5	24.4
space	48.8	1/8	1/8	7.62	-	0.35	8.36	1.39	29.2	27.9

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IIIB7

DILUTED Pu CYLINDERS, 6.0" DIAMETER, 7.5" THICK Th REFLECTOR

Pu(1w/o Ga), ~5% Pu^{240}, as discs 5.934" dia x 0.123", in thin Ni cans of outside dimensions 5.967" dia x 0.135"; ρ (Pu) = 15.61 g/cm^3

Diluent plates 5.97" dia x 1/8" or 1/4"

Steel guide sleeve, 0.030" thick, within reflector cylinder; $\bar{\rho}$ (Th) = 11.9 g/cm^3

Reference (51)

diluent (A)	vol % Pu	repeated layers, nom thickness (in.)		core-average ρ $(g/cm^3)^a$			h_c (in.)	h_c/d^a	m_c (kg Pu)	m_{max} (kg Pu)
		Pu	A	$\bar{\rho}$ (Pu)	$\bar{\rho}$ (A)	$\bar{\rho}$ (Ni)				
none	92.9	1/8	-	14.50	-	0.66	1.92	0.32	12.7_5	11.8
U(0.28)	63.5	1/4	1/8	9.91	5.99	0.45	3.23	0.54	14.6_5	12.6
steel[b]	62.5	1/4	1/8	9.76	2.50	0.45	3.58	0.60	16.0	14.4
Th	62.9	1/4	1/8	9.82	3.63	0.45	3.69	0.61_5	16.6	16.2
Al[c]	63.7	1/4	1/8	9.95	0.85	0.45	3.61	0.60	16.4_5	16.2
space	63.7	1/4	1/8	9.95	-	0.45	3.80	0.63	17.3_5	16.2
U(0.28)	47.5	1/8	1/8	7.42	9.04	0.34	5.16	0.86	17.5_5	17.1
steel[b]	47.6	1/8	1/8	7.43	3.80	0.34	6.33	1.06	21.5_5	20.7
Th	47.7	1/8	1/8	7.45	5.52	0.34	6.78	1.13	23.2	22.5
Al[c]	48.6	1/8	1/8	7.59	1.30	0.35	6.55	1.09	22.8	21.6
space	49.0	1/8	1/8	7.65	-	0.35	7.34	1.22	25.7_5	25.2
U(0.28)	32.4	1/8	1/4	5.06	12.27	0.23	13.26	2.21	30.8	27.0

[a] Based on 6.00" diameter to include reflector clearance

[b] Stainless steel, type 304

[c] Aluminum, type 1100F

TABLE IV

U-233 METAL SPHERES

Reflected cores consist of hemispheres coated with 0.005" thick Ni

	core				spheric reflector			m_c	
	composition			$\bar{\rho}$ (U)					
ref	w/o U^{233}	w/o U^{234}	w/o U^{238}	(g/cm^3)	material	$\bar{\rho}$ (g/cm^3)	thickness (in.)	(kg U^{233})	m_{max}
(1)	98.2	1.2	0.6	18.45		none		16.09 ± 0.05[a]	critical
(52)	98.7[b]	0.5	0.8	18.42	U(N)	19.0	7.86	5.63 ± 0.03[c]	critical
(48)	98.2	1.1	0.7	18.64	U(N)	18.92	2.09 ± 1%	7.47[d] (3.622" dia)	$>m_c$[e]
(48)	98.2	1.1	0.7	18.62	U(N)	18.92	0.906 ± 1%	9.84[d] (3.972" dia)	$>m_c$[e]
(48)	98.2	1.1	0.7	18.64	W-alloy[f]	17.21	2.28 ± 1%	7.47[d] (3.622" dia)	$>m_c$[e]
(48)	98.2	1.1	0.7	18.62	W-alloy[f]	17.21	0.960 ± 1%	9.84[d] (3.972" dia)	$>m_c$[e]
(48)	98.2	1.1	0.7	18.64	Be (98%)	1.83	1.652 ± 1%	7.47[d] (3.622" dia)	$>m_c$[e]
(48)	98.2	1.1	0.7	18.62	Be (98%)	1.83	0.805 ± 1%	9.84[d] (3.972" dia)	$>m_c$[e]

[a] Corrected for effects of Ni coating, supports and small asphericity

[b] Analysis available for one hemisphere only

[c] Corrected for effects of Ni coating, oversize core and compensating gap between core and reflector

[d] Corrected for effects of Ni and clearances between assembly parts

[e] Effect of small compensating gap was adjusted to zero; reflector thickness modified

[f] Composition 91.3 w/o W, 5.5 w/o Ni, 2.5 w/o Cu, 0.7 w/o Zr

TABLE VA

Pu OR U-233 METAL SPHERES WITHIN U(~93) METAL SPHERES

ref	central ball: composition	central ball: $\bar{\rho}$ (Pu, U) (g/cm^3)	central ball: dia (in.)	U(~93) shell, $\bar{\rho}$ = 18.8 g/cm^3: enrichment w/o U^{235}	U(~93) shell: critical thickness (in.)	U(N) reflector sphere, $\bar{\rho}$ = 19.0 g/cm^3 thickness (in.)	m_c: kg Pu or U^{233}	m_c: kg U^{235}	M_{max}
(48)	Pu(1 w/o Ga), 4.9% Pu^{240}	15.62	3.970	93.17	0.652 ± 1%	none	8.39	12.64[a]	$m_{max} > m_c$[b]
(53)	Pu(1 w/o Ga), 1.5% Pu^{240}	15.56	3.510	93.18	1.006	none	5.72	18.8 ± 0.3[a]	65
(53)	Pu(1 w/o Ga), 4.7% Pu^{240}	15.60	2.486	93.17	1.948	none	2.02_2	36.7 ± 0.1[a]	130
(53)	Pu(1 w/o Ga), 1.5% Pu^{240}	15.62	2.484	93.17	1.938	none	2.02_4	36.3_5 ± 0.1[a]	118
(53)	Pu (100%), 4.7% Pu^{240}	19.22	2.484	93.17	1.651	none	2.52_7	26.8 ± 0.1[c]	233
(54)	Pu (100%), 2.34% Pu^{240}	19.48	2.130	93.2	0.974	7.45	1.615	8.87[d]	critical
(54)	Pu (100%), 4.73% Pu^{240}	19.42	2.130	93.2	0.988	7.43	1.610	9.09[d]	critical
(54)	Pu (100%), 16.1% Pu^{240}	19.43	2.130	93.2	1.039	7.38	1.611	9.90[d]	m_{max} = 9.75 kg U^{235}
(48)	U^{233} (98.2 w/o)[e]	18.62	3.972	93.30	0.478 ± 1%	none	9.84	8.58[a]	$m_{max} > m_c$[b]
(48)	U^{233} (98.2 w/o)[e]	18.64	3.622	93.16	0.780 ± 1%	none	7.47	13.77[a]	$m_{max} > m_c$[b]
(53)	U^{233} (98.9 w/o)[f]	18.35	2.478	93.17	1.896	none	2.37_1	34.8 ± 0.1[a]	138

[a] Corrected for effects of 0.005" thick Ni on Pu or U^{233} hemispheres and for clearances between assembly parts

[b] Effect of small compensating gap was adjusted to zero; reflector thickness modified

[c] Corrected for effects of 0.005" thick Cu about Pu sphere and for clearances between assembly parts

[d] No correction for 0.012" thick gap containing 0.010" thick Ni between Pu and U(93.2)

[e] 1.1 w/o U^{234}, 0.7 w/o U^{238}

[f] 0.9 w/o U^{234}, 0.2 w/o U^{238}

TABLE VB

Pu METAL CYLINDER WITHIN U(93.2) METAL CYLINDER, THICK U(N) REFLECTOR

The Pu(1w/o Ga) contains ~6% Pu^{240}; Pu pieces coated with 0.005" thick Ni

Dimensions of Pu and outside dimensions of U(93.2) are such that h/d values are the same

Cores are approximately centered in a U(N) cylinder, 18.0" dia x 10", of density 19.0 g/cm^3

Reference (53)

h_c/d (Pu and U^{235})	Pu cavity dimensions (in.)	$\bar{\rho}$ (Pu) (g/cm^3)	$\bar{\rho}$ (U-93.2) (g/cm^3)	m_c [a]		m_{max}
				kg Pu	kg U^{235}	
0.20	4.315 dia x 0.875	14.98	18.66	3.14 (fixed)	13.0 ± 0.2	11.9 kg U^{235}
0.30	4.315 dia x 1.290	15.29	18.30	4.73 (fixed)	5.3 ± 0.2	4.2 kg U^{235}
1.00	2.235 dia x 2.231	14.83	18.58	2.13 (fixed)	9.7 ± 0.2	8.2 kg U^{235}
0.44	4.315 dia cyl	15.34	none	6.91 ± 0.04	-	6.47 kg Pu

[a] No correction for effect of Ni or 0.06 $in.^3$ central source cavity

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