LA-7170-MS
Informal Report

Experimental Criticality Specifications

An Annotated Bibliography Through 1977

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

An Affirmative Action/Equal Opportunity Employer

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG. 36

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

Microfiche $ 3.00

001-025	4.00	126-150	7.25	251-275	10.75	376-400	13.00	501-525	15.25
026-050	4.50	151-175	8.00	276-300	11.00	401-425	13.25	526-550	15.50
051-075	5.25	176-200	9.00	301-325	11.75	426-450	14.00	551-575	16.25
076-100	6.00	201-225	9.25	326-350	12.00	451-475	14.50	576-600	16.50
101-125	6.50	226-250	9.50	351-375	12.50	476-500	15.00	601-up	--1

1. Add $2.50 for each additional 100-page increment from 601 pages up.

LA-7170-MS
Informal Report

UC-46
Issued: May 1978

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

Experimental Criticality Specifications

An Annotated Bibliography Through 1977

Compiled by

Hugh C. Paxton

EXPERIMENTAL CRITICALITY SPECIFICATIONS

An Annotated Bibliography Through 1977

Compiled by

Hugh C. Paxton

ABSTRACT

Literature references give sources of experimental nuclear criticality data that have relevance to criticality safety. Notes indicate principal fissile materials, diluents, and special geometries, but are not critical specifications.

INTRODUCTION

This compilation gives sources of experimental criticality parameters of systems containing ^{235}U, ^{233}U, and ^{239}Pu. The intent is to cover basic data for criticality safety applications.

A reasonably complete bibliography of criticality data sources appeared in the 1964 publication, "Critical Dimensions of Systems Containing U^{235}, Pu^{239}, and U^{233}," the third item in this report. Since that time, there had been no generally available updating, although individuals have maintained files of the literature. The need for this new compilation became apparent during a comprehensive revision of "The Nuclear Safety Guide."

Not included in this listing are descriptions of computationally complex reactor systems, subcritical data that do not extrapolate well to criticality, and information from periodic progress reports or ANS Transactions. Results of some early experiments that have been supplanted are included for historical interest.

Abbreviations are illustrated as follows. U(1.4) and U(93) mean uranium containing 1.4 wt% and 93 wt% ^{235}U. U(nat) means natural uranium as usually encountered. C/U and H/^{235}U imply atomic ratios unless specified as volume or mass ratios. Stainless steel is represented by ss.

I. COMPILATIONS

C. L. Schuske and H. C. Paxton, "History of Fissile Array Measurements in the United States," Nucl. Technol. **30**, 101-137 (August 1976).

Recapitulation of experimental subcritical and critical data for ^{235}U and Pu metal and solutions, and ^{233}U solutions.

H. C. Paxton, "Los Alamos Critical-Mass Data," Los Alamos Scientific Laboratory report LA-3067-MS, Rev. (December 1975).

Tabulation of nonreactor data with accuracy indexes, mostly solid configurations of ^{235}U, Pu, ^{233}U (D_2O, phosphate solutions).

H. C. Paxton, J. T. Thomas, D. Callihan, and E. B. Johnson, "Critical Dimensions of Systems Containing U^{235}, Pu^{239}, and U^{233}," USAEC report TID-7028 (June 1964).

Compilation of significant experimental data through 1963, some specifications transformed for uniformity of correlations.

E. D. Clayton, "Nuclear Safety in Chemical and Metallurgical Processing of Plutonium," *Criticality Control in Chemical and Metallurgical Plant,* Proc. Karlsruhe Symposium (O.E.C.D., Paris, 1961) pp. 367-392.

Comprehensive review of experimental criticality data for Pu.

D. Callihan, "A Review of Criticality Data Obtained by Experimental Methods," *Criticality Control in Chemical and Metallurgical Plant,* Proc. Karlsruhe Symposium (O.E.C.D., Paris, 1961) pp. 139-172.

Comprehensive enriched-uranium data, sources for ^{233}U and Pu.

A. D. Callihan, J. W. Morfitt, and J. T. Thomas, "Small Thermal Homogeneous Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 145-155.

Idealized summary of hydrogen-moderated ^{235}U, ^{233}U, Pu systems; includes steel-water reflection, critical-mass reduction by distributing concentration.

II. SIMPLE UNITS

A. U(≥90)

1. Solutions, Slurries

P. Lécorché and R. L. Seale, "A Review of the Experiments Performed to Determine the Radiological Consequences of a Criticality Accident," Oak Ridge Criticality Data Center report Y-CDC-12 (November 3, 1973).

$U(93)O_2(NO_3)_2$ solution, 22 to 380 g U/liter, in bare 300- and 800-mm-diam cylinders (incidental to excursion experiments).

T. A. Fox, R. A. Mueller, and D. Fieno, "Criticality Study of NASA Solution Reactors with 25.4 Centimeter-Diameter Cylindrical Stainless-Steel Tanks," National Aeronautics and Space Administration report NASA TM X-2381 (September 1971).

$U(93.2)O_2F_2$ solution, $H/^{235}U$ = 74 to 280, in bare 0.16- or 0.32-cm-wall ss cylinders; agreement with Oak Ridge.

G. Tuck and H. E. Clark, "Critical Parameters of a Uranium Solution Slab-Cylinder System," Nucl. Sci. Eng. **40**, 407-413 (June 1970).

$U(93.2)O_2(NO_3)_2$ solution, 505 g U/liter, 120.7-cm-square Plexiglas-reflected slab.

R. E. Rothe, C. L. Schuske, and E. E. Hicks, "The Criticality of a Uranium-Solution Slab Under Various Reflector Conditions," Nucl. Appl. Technol. 7, 505-512 (December 1969).

$U(93)O_2(NO_3)_2$ solution, 500 g U/liter, ~120-cm-square slab, bare and Plexiglas reflected.

J. G. Bruna, J. P. Brunet, R. Caizergues, C. Clouet d'Orval, and P. Verriere, "Results of Homogeneous Critical Experiments Carried Out with ^{239}Pu, ^{235}U and ^{233}U," (in French) *Criticality Control of Fissile Materials,* Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 235-248.

ALECTO at Saclay: 25- to 42-cm-diam cylinders, ^{239}Pu-, ^{235}U-, ^{233}U-nitrate solutions, 15 to 18 g Pu/liter, 30 to 300 g ^{235}U/liter, 25 to 250 g ^{233}U/liter, bare, water reflector (see II.D.1 and II.G).

B. G. Dubovskii, A. V. Kamaev, F. M. Kuznetsov, G. M. Vladykov, G. A. Popov, and Yu. D. Palamarchuk, "Critical Parameters for Aqueous Solutions of $UO_2(NO_3)_2$," J. Nucl. Energy **19**, 775-781 (October 1965).

277 g U(90)/liter in 17-cm-diam cylinder with lateral and bottom water reflector, and in bare 24-cm-diam cylinder.

B. G. Dubovsky, A. V. Kamaev, V. V. Orlov, G. M. Vladykov, V. N. Gurin, F. M. Kuznetsov, V. P. Kochergin, I. P. Markelov, G. A. Popov, and V. J. Sviridenko, "The Critical Parameters of Aqueous Solutions of $UO_2(NO_3)_2$ and Nuclear Safety," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 254-263.

32 to 287 g U(90)/liter as parallelepipeds, bare, water, and water-steel reflected; also U(10), U(5) cylinders (see II.B.1 and II.C.1).

D. Breton, P. Lécorché, and C. Clouet d'Orval, "Criticality Studies," (in French) Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 234-243.

Saclay: solutions at 60 g Pu/liter and ~30 to 100 g ^{235}U/liter as U(90) in bare 42-cm-diam cylinder and water-reflected 30-cm-diam cylinder, also spaced reflectors, interaction of two 10-cm-diam cylinders with one at 30-cm diam; Dijon: Pu solution in 50-cm-o.d. by 30-cm-i.d. annulus, interaction of two annuli (see II.D.1 and IV.B).

D. R. Bach, J. A. Bistline, S. I. Bunch, R. J. Cerbone, F. Feiner, W. Skolnik, R. E. Slovacek, and S. Weinstein, "Comparison of Knolls Atomic Power Laboratory Clean Critical and Subcritical Experiments with Calculations," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. II, pp. 391-445.

U(93)O_2-ZrO_2-paraffin compacts, H/^{235}U = 229, parallelepipeds, bare and reflected with polyethylene and ZrO_2-paraffin; 0.0016-in.-thick U(93) foil in Zr and H_2O, range of metal/water, effect of elevated temperature (see II.A.3).

R. H. Masterson, J. D. White, and T. J. Powell, "The Limiting Critical Concentrations for Pu^{239} and U^{235} in Aqueous Solutions," Hanford Atomic Products Operation report HW-77089 (March 27, 1963).

Limiting critical concentration of $Pu(NO_3)_4$ solution 8.0 g Pu/liter, of U(93)O_2F_2 solution 12.0 g ^{235}U/liter, from PCTR measurements (see II.D.1).

J. K. Fox and L. W. Gilley, "Some Studies of Water, Styrofoam, and Plexiglas Reflectors," Oak Ridge National Laboratory report ORNL-CF-58-9-39 (October 3, 1958).

U(93)O_2F_2 solution, H/^{235}U = 293, 6-in.-thick by 48-in.-wide slabs.

J. C. Allred, P. J. Bendt, and R. E. Peterson, "Critical Measurements on UO_3-H_3PO_4 Solutions," (Letter) Nucl. Sci. Eng. 4, 498-500 (September 1958).

H/U(93.5) = 198, 220, 248, 300, in 31.5-cm-diam cylinder with 9-cm-thick Fe reflector.

J. K. Fox and L. W. Gilley, "Critical Parameters for Poisoned Annular Cylinders Containing Aqueous Solutions of U^{235}," Oak Ridge National Laboratory report ORNL-CF-58-8-5 (August 1, 1958).

U(93)O_2F_2 solution, H/^{235}U = 50.4 and 309, in 10- to 30-in.-o.d. annuli with Cd-lined interior filled with water.

J. K. Fox, L. W. Gilley, and J. H. Marable, "Critical Parameters of a Proton-Moderated and Proton-Reflected Slab of U^{235}," Nucl. Sci. Eng. 3, 694-697 (June 1958).

U(93)O_2F_2 solution, H/^{235}U = 44.7 and 51.5, 2.0- to 2.12-in.-thick by 58.5-in.-wide slabs, water reflected.

J. K. Fox, L. W. Gilley, and D. Callihan, "Critical Mass Studies, Part IX, Aqueous U^{235} Solutions," Oak Ridge National Laboratory report ORNL-2367 (March 4, 1958).

U(93.2)O_2F_2 solution, H/^{235}U = 27 to 75; interaction of three and seven 6- and 8-in.-diam cylinders in air and water; individual 6- to 30-in.-diam cylinders and 9-in.-diam sphere, bare, water reflected; 8- to 20-in.-o.d. annuli; also "Y" and "cross," and comparison of furfural, concrete, graphite, firebrick reflectors with water (see IV.A.1).

J. T. Thomas, J. K. Fox, and D. Callihan, "A Direct Comparison of Some Nuclear Properties of U-233 and U-235," Nucl. Sci. Eng. 1, 20-32 (March 1956).

^{233}U and ^{235}U as uranyl fluoride solutions, H/^{233}U ~380 and 600, H/^{235}U ~240 and 460, 26.4- and 32.0-cm-diam spheres in water (see II.G).

J. R. Brown, B. H. Noordhoff, and W. O. Bateson, "Critical Experiments on a Highly Enriched Homogeneous Reactor," Westinghouse Atomic Power Division report WAPD-128 (May 1955).

$U(93)O_2(NO_3)_2$ solution, $H/^{235}U$ = 1600 to 1800, 36-in.-diam cylinder, bare, and with 8-in.-thick water radially.

D. F. Cronin and D. Callihan, "Critical Mass Studies, Part VII, Aqueous Uranium Slurries," Oak Ridge National Laboratory report ORNL-1726 (July 1, 1954).

$U(93)O_3$-H_2O slurries, $H/^{235}U$ = 90 to 668, 12-in.-diam cylinder in water (hemisphere bottom), critical height vs $H/^{235}U$ same as for solution.

D. Callihan, D. F. Cronin, J. K. Fox, and J. W. Morfitt, "Critical Mass Studies, Part V," Oak Ridge Gaseous Diffusion Plant report K-643 (June 30, 1950).

$U(93.3)O_2(NO_3)_2$ solution, $H/^{235}U$ = 62 to 733, $N/^{235}U$ = 2.9, 5.4, 7.5, $P/^{235}U$ = 0, 15.8, 53, 8- or 10-in.-diam cylinders with 15-in.-o.d. reflectors of water, $UO_2(NO_3)_2$ solution, bismuth subcarbonate, phosphoric acid, and various thicknesses of steel; also 1-in.-diam tubes of P and Bi latticed in bare 15-in.-diam cylinder (as in Pu processes).

C. K. Beck, A. D. Callihan, J. W. Morfitt, and R. L. Murray, "Critical Mass Studies, Part III," Oak Ridge Gaseous Diffusion Plant report K-343 (April 19, 1949).

$U(93)O_2F_2$ solution, $H/^{235}U$ = 32 to 999, 6.5- to 15-in.-diam cylinders, bare, water reflected.

2. Poisoned Solutions

R. E. Rothe, D. L. Alvarez, and H. E. Clark, "The Criticality of Periodically Boron-Poisoned Enriched Uranium Solution Systems," Nucl. Technol. **25**, 502-516 (March 1975).

$U(93.2)O_2(NO_3)_2$, 52.2 to 451 g U/liter, in bare 107-cm-diam tank containing 0.26-cm-thick ss plates with 1.0 wt% B at various spacings.

R. E. Rothe, "Critical Measurements on an Enriched Uranium Solution," Nucl. Sci. Eng. **35**, 267-276 (February 1969).

$U(93.2)O_2(NO_3)_2$ solution, $H/^{235}U$ = 51, in bare 107-cm-diam tank unpoisoned, and containing distributed 0.25-cm-thick plates with 1 wt% B.

J. T. Thomas, J. K. Fox, and E. B. Johnson, "Critical Mass Studies—Part XIII, Borosilicate Glass Raschig Rings in Aqueous Uranyl Nitrate Solutions," Oak Ridge National Laboratory report ORNL-TM-499 (February 6, 1963).

$U(92.6)O_2(NO_3)_2$ solution, 63 to 415 g U/liter, critical solution a source for solution-glass exponentials, glass rings from 0.5 to 5.7 wt% B; typical conclusion: $k_\infty < 1$ if > 22 vol% of glass with 4 wt% B.

3. Hydrogenous Compacts, Mixtures

V. Drüke, D. Filges, N. Kirch, and R. D. Neef, "Experimental and Theoretical Studies of Criticality Safety by Ingress of Water in Systems with Pebble-Bed High-Temperature Gas-Cooled Reactor Fuel," Nucl. Sci. Eng. **57**, 328-332 (August 1975).

6-cm-diam spheres at $C/^{235}U$ = 7550 in 150-cm-diam cylinder, polyethylene to simulate 0 to 14.4% water, pulsed-neutron measurements give k_{eff} = 0.69 to 0.89.

R. Caizergues, E. Deilgat, P. Lécorché, L. Maubert, and H. Revol, "Criticality of Liquid Mixtures of Highly ^{235}U-Enriched Uranium Hexafluoride and Hydrofluoric Acid," Oak Ridge Criticality Data Center report Y-CDC-9 (May 1971).

$U(93)F_6$-HF, H/U = 0 to 80, 400-, 450-, 510-, 540-mm-diam spheres, water reflected.

D. W. Magnuson, "Critical Experiments with Enriched Uranium Metal-Polyethylene, -Plexiglas, and -Teflon Mixtures," Oak Ridge National Laboratory report ORNL-TM-2082 (February 1968).

U(93) slabs, 12.7 by 25.4 cm and 25.4-cm-square, solid and interleaved in thicknesses of 0.12 to 1.4 cm, bare and polyethylene reflected: max. H/U = 5 for U-polyethylene; U-Plexiglas and U-Teflon only 25.4 cm square, unreflected (see II.A.6 and II.A.7).

G. A. Jarvis and C. B. Mills, "Critical Mass Reduction," Los Alamos Scientific Laboratory report LA-3651 (March 22, 1967).

U(93)-polyethylene, 0.0012-in.-thick U, reflected by ~12-in. Be (min. critical mass 290 g ^{235}U).

D. R. Bach, J. A. Bistline, S. I. Bunch, R. J. Cerbone, F. Feiner, W. Skolnik, R. E. Slovacek, and S. Weinstein, "Comparison of Knolls Atomic Power Laboratory Clean Critical and Subcritical Experiments with Calculations," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. II, pp. 391-445.

U(93)O_2-ZrO_2-paraffin compacts, H/^{235}U = 229, parallelepipeds, bare and reflected with polyethylene and ZrO_2-paraffin; 0.0016-in.-thick U(93) foil in Zr and H_2O, range of metal/water, effect of elevated temperature (see II.A.1).

J. W. Weale, M. H. McTaggart, H. Goodfellow, and W. J. Paterson, "Operation Experience with the Zero-Energy Fast Reactor Vera," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964), Vol. I, pp. 159-195.

U(93)-ss-graphite at C/^{235}U = 7.8 or 10.7, U(93)-ss-graphite-polyethylene at C/^{235}U = 4.4 to 6.3 and H/^{235}U = 1.0, U(32)-ss-graphite at C/^{235}U = 5.8, U(32)-ss-graphite-polyethylene at C/^{235}U = 6.3 and H/^{235}U = 1.0, Pu-Cu-ss-graphite at C/Pu = 3.0 to 6.0; each in thick U(nat)-ss (see II.A.4, II.B.1, II.B.2, and II.D.3).

D. H. Fraembs, "Uranium-Beryllium-Hydrogen Systems, An Experimental Study," General Electric Nuclear Materials and Propulsion Operation report APEX-637 (July 1961).

BeO-Plexiglas-^{235}U foil cores (15-in.-long by 9.4- to 12.6-in.-diam), H/^{235}U = 229 to 422, Be/^{235}U = 95 to 219, ≥ 12-in.-thick Be inner reflector, 19-in.-thick Plexiglas outer reflector (see II.A.4).

G. A. Linenberger, J. D. Orndoff, and H. C. Paxton, "Enriched-Uranium Hydride Critical Assemblies," Nucl. Sci. Eng. 7, 44-57 (January 1960).

Pseudospheres of 0.5-in.-min compacts approximating U(93)H_3C in 8-in. U(nat), Ni, or Ni in U(nat); also LA-1159, May 22, 1950.

F. J. Jankowski, "Research Experience with Plastic-Moderated Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 747-762.

C. E.: 0.002-in. U(93.15) foil with polyethylene, B, Al, Zr at H/^{235}U = 25 to 280, B/^{235}U = 0 to 0.27, 14 by 14 by 21-in. core, polyethylene reflector (KAPL ^{235}U-polyethylene-Al assemblies incompletely described).

R. H. White, "Topsy, A Remotely Controlled Critical Assembly-Machine," Nucl. Sci. Eng. 1, 53-61 (March 1956).

^{235}U metal in thick U(nat) at 100%, 70%, 50% of full density and ^{235}U enrichment; ^{235}U metal in thick Ni; ~UH_3C in thick Ni; better specifications published later; also LA-1251, May 1, 1951 (see II.A.7 and II.B.2).

J. D. McLendon and J. W. Morfitt, "Critical Mass Tests on Oralloy Machine Turnings," Oak Ridge Y-12 Plant report Y-A2-71 (February 29, 1952).

U(93.4) as ~0.005-in.-thick turnings in water, H/^{235}U = 60, 80, 120, one to six 8- or 10-in.-diam cylinders in water; critical mass ~18% above that of corresponding solution (see IV.A.1).

H. C. Paxton and G. A. Linenberger, "Polythene-25 Critical Assembly and Neutron Distribution Studies," Los Alamos Scientific Laboratory report LA-749 (September 30, 1949).

0.5-in. cubes of U(94.5) and polyethylene to average $UH_{8.8}C_{1.9}$, pseudosphere in 8-in. U(nat).

C. K. Beck, D. Callihan, and R. L. Murray, "Critical Mass Studies, Part I," Clinton Engineering Works report A-3691 (February 11, 1947).

1-in. cubic U(95)CF_6 and polyethylene parallelepipeds averaging H/^{235}U = 5, 10, 20, thick paraffin reflector.

4. Nonhydrogenous Moderators

J. C. Hoogterp, G. E. Hansen, and H. C. Paxton, "Bare U(93)C_{170} Assembly," Los Alamos Scientific Laboratory report LA-4798-MS (May 1974).

0.005- and 0.010-in-thick U foil interleaved with graphite, bare 122-cm cube.

W. Y. Kato, R. J. Armani, R. P. Larsen, P. E. Moreland, L. A. Mountford, J. M. Gasidlo, R. J. Popek, and C. D. Swanson, "An Integral Measurement of Plutonium-239 and Uranium-233 Alpha," Nucl. Sci. Eng. **45**, 37-46 (July 1971).

1/8-in.-thick U(93) interleaved with U(0.21), BeO, Al, Be/^{235}U = 9.6, reflected by 14-in. Fe in 6-in. U(0.21).

J. P. Phelps and E. V. Weinstock, "Criticality Measurements on Nearly Homogeneous Enriched Uranium-Graphite Systems," Nucl. Sci. Eng. **34**, 237-250 (December 1968).

0.015-in.-thick 14 wt% U(93.15)-Al interleaved with graphite, C/^{235}U = 960 to 2.3 x 10^4, parallelepipeds, minimal reflection.

D. K. Butler, R. C. Doerner, and W. G. Knapp, "Measurements and Analysis of Al-, Al_2O_3-, and BeO-reflected Fast Critical Experiments," *Fast Critical Experiments and Their Analysis,* Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 186-194.

U(11)-Al-Fe, U(16)-W-Al-Fe at W/^{235}U = 2.7, U(21)-W-Al-Fe at W/^{235}U = 4.8, U(93)-W-Al-Fe at W/^{235}U = 5.9, U(93)-W-Al-Fe at W/^{235}U = 4.8 and C/^{235}U = 0 or 6.6, each in thick Al; U(93)-W-Al-Fe at W/^{235}U = 4.8 and O/^{235}U = 0 or 2.0, in various combinations of Al, Al_2O_3 and BeO (see II.A.6 and II.B.2).

N. N. Ponomarev-Stepnoi and S. S. Lomakin, "Study of a Critical Assembly Containing a Beryllium Moderator," J. Nucl. Energy **19**, 291-298 (April 1965).

0.05-cm-thick Teflon-U_3O_8 interleaved with Be, Be/^{235}U = 1165, 1745, 3481, essentially unreflected.

D. H. Carter, W. G. Clarke, C. Hunt, J. Marshall, D. B. McCulloch, J. E. Sanders, and C. R. Symons, "Measurements of Buckling and Relative Reaction Rates in Some Plutonium-Graphite Assemblies," J. Nucl. Energy **18**, 105-124 (January 1964).

0.2-in.-thick Pu-Al at Al/Pu = 120, interleaved with graphite, C/^{239}Pu = 2420 to 14520; also U(93) with graphite, C/^{235}U = 3490, Al/^{235}U = 41; buckling to ~0.3% (see II.D.3).

R. G. Bardes, J. R. Brown, M. K. Drake, P. U. Fischer, D. C. Pound, J. B. Sampson, and H. B. Stewart, "High-Temperature, Gas-Cooled Reactor Critical Experiment and Its Application," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. III, pp. 35-61.

$^{235}U_3O_8$-ThO_2-graphite compacts in graphite, C/^{235}U = 2775, Th/^{235}U = 12, graphite reflector.

G. M. Benson and R. H. Fox, "Room Temperature Critical Measurements on Thorium-Loaded, Graphite-Moderated, Oralloy-Fueled Systems," Lawrence Livermore Laboratory report UCRL-6901 (June 30, 1962).

0.001-, 0.002-in.-thick U(93.2), 0.002-in.-thick Th, mostly bare 48-in.-square by 40- to 52-in.-high cores, C/^{235}U = 599 and C/Th = 908 (or 0), C/^{235}U = 1151 and C/Th = 901 (or 0), C/^{235}U = 2285 and C/Th = 1820 (or 0).

J. J. McEnhill and J. W. Weale, "Integral Experiments on Fast Systems of Plutonium, Uranium and Thorium" *Physics of Fast and Intermediate Reactors,* Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 253-262.

Pu metal spheres, bare, and in U(nat), Fe, C; U(45.5) metal slabs, 11.6-, 16.9-, 22.1-in.-diam, bare, and in U(nat), C, steel, Al; U(92.9)-graphite core at C/^{235}U = 7.8, 27-cm diam by 38-cm high, U(nat) reflector (see II.B.2 and II.D.4).

J. W. Weale, M. H. McTaggart, H. Goodfellow, and W. J. Paterson, "Operation Experience with the Zero-Energy Fast Reactor Vera," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. I, pp. 159-195.

U(93)-ss-graphite at C/^{235}U = 7.8 or 10.7, U(93)-ss-graphite-polyethylene at C/^{235}U = 4.4 to 6.3 and H/^{235}U = 1.0, U(32)-ss-graphite at C/^{235}U = 5.8, U(32)-ss-graphite-polyethylene at C/^{235}U = 6.3 and H/^{235}U = 1.0, Pu-Cu-ss-graphite at C/Pu = 3.0 to 6.0; each in thick U(nat)-ss (see II.A.3, II.B.1, II.B.2, and II.D.3).

D. H. Fraembs, "Uranium-Beryllium-Hydrogen Systems, An Experimental Study," General Electric Nuclear Materials and Propulsion Operation report APEX-637 (July 1961).

BeO-Plexiglas-^{235}U foil cores 15-in. long by 9.4- to 12.6-in. diam, H/^{235}U = 229 to 422, Be/^{235}U = 95 to 219, ≥12-in.-thick Be inner reflector, 19-in.-thick Plexiglas outer reflector (see II.A.3).

F. A. Kloverstrom, R. M. R. Deck, and A. J. Reyenga, "Critical Measurements on Near-Homogeneous BeO-Moderated, Enriched Uranium Fueled Systems," Nucl. Sci. Eng. 8, 221-225 (September 1960).

0.001- and 0.002-in.-thick U(93.2) interleaved with BeO, Be/^{235}U = 247 to 7660, bare parallelepipeds; also UCRL-5369, Pt I, July 1, 1959.

E. L. Zimmerman, "Two Beryllium-Moderated Critical Assemblies," Oak Ridge National Laboratory report ORNL-2201 (October 21, 1958).

0.01-in.-thick U(93.4) interleaved with Be, bare 21.0 by 21.0 by 23.3 in. at Be/^{235}U = 390, 24.0 by 24.1 by 28.4 in. at Be/^{235}U = 1560.

H. L. Reynolds, "Critical Measurements and Calculations for Enriched-Uranium Graphite-Moderated Systems," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 632-642.

0.001- or 0.002-in.-thick U(93.5) interleaved with graphite, C/^{235}U = 297 to 10500, some partially reflected by 6-in. graphite, 3- to 6-in. Be; also UCRL-5175, March 31, 1958, and UCRL-4983-T, November 1, 1957.

G. E. Hansen, J. C. Hoogterp, J. D. Orndoff, and H. C. Paxton, "Beryllium-Reflected, Graphite-Moderated Critical Assemblies," Los Alamos Scientific Laboratory report LA-2141 (October 11, 1957).

0.002- or 0.005-in.-thick U(93.2) interleaved with graphite, pseudocylinders, C/U = 116 to 952 in ~13-cm Be, C/U ~350 in ~20-cm Be.

R. N. Olcott, "Homogeneous Heavy Water Moderated Critical Assemblies. Part I. Experimental," Nucl. Sci. Eng. 1, 327-341 (August 1956).

UO_2F_2 solution, D/^{235}U = 34 to 430, as 13.5- to 18.5-in.-diam spheres in 35-in.-o.d. D_2O; D/^{235}U = 230 to 2080 as bare 25- and 35-in.-diam cylinders.

J. C. Hoogterp, "Critical Masses of Graphite-Tamped Heterogeneous Oy Graphite Systems," Los Alamos Scientific Laboratory report LA-1732 (May 1954).

Interleaved 10.5-in.-diam U(93) and graphite plates in 2-in. graphite, 0.32-, 0.63-, 0.94-in.-thick U, 0-, 0.5-, 1.0-, 2.0-in.-thick graphite.

E. L. Zimmerman, "A Graphite Moderated Critical Assembly CA-4," Oak Ridge Y-12 Plant report Y-881 (December 7, 1952).

0.01-in.-thick U(93) interleaved with graphite, C/U = 991, bare 51 by 51 by 44 in.

5. Reflector Moderators

H. C. Paxton, G. A. Jarvis, and C. C. Byers, "Reflector-Moderated Critical Assemblies," Los Alamos Scientific Laboratory report LA-5963 (July 1975).

U(93) foil and U(93)-graphite elements in 1-m-diam by 1-m-high cavity in 0.49-m-thick D_2O, also in 0.39-m-diam by 0.79-m-high cavity in 0.36- to 0.47-m-thick Be.

J. F. Kunze, J. H. Lofthouse, and C. G. Cooper, "Benchmark Gas Core Critical Experiment," Nucl. Sci. Eng. 47, 59-65 (January 1972).

U(93.2)F_6 in 63-cm-diam sphere, 91-cm-i.d., 96.6-cm-thick D_2O; in shell, only Al, Al-polystyrene-polyethylene, Al-ss.

J. F. Kunze, G. D. Pincock, and R. E. Hyland, "Cavity Reactor Critical Experiments," Nucl. Appl. 6, 104-115 (February 1969).

0.001-in.-thick U(93.2) distributed in 6-ft-diam by 4-ft-long cavity in ~3-ft-thick D_2O, with variations.

R. M. Spencer, "Preliminary Critical Assemblies of the Reflector Moderator Reactor," Oak Ridge National Laboratory report ORNL-1770 (November 22, 1954).

16.2 wt% U(93.2)F_4-55.0% ZrO_2-19.9% NaF-8.8% C-0.25% H_2 mixture as 1.25- to 3.75-in. annulus about ~6- to 9-in.-diam Be, reflector ~12-in.-thick Be in 6-in.-thick graphite.

6. Unmoderated Compounds, Mixtures

D. W. Magnuson, "Critical Experiments with Enriched Uranium Metal-Polyethylene, -Plexiglas, and -Teflon Mixtures," Oak Ridge National Laboratory report ORNL-TM-2082 (February 1968).

U(93) slabs, 12.7- by 25.4-cm and 25.4-cm-square, solid and interleaved in thicknesses of 0.12 to 1.4 cm, bare and polyethylene reflected: max. H/U = 5 for U-polyethylene; U-Plexiglas and U-Teflon only 25.4-cm square, unreflected (see II.A.3 and II.A.7).

D. K. Butler, R. C. Doerner, and W. G. Knapp, "Measurements and Analysis of Al-, Al_2O_3-, and BeO-reflected Fast Critical Experiments," *Fast Critical Experiments and Their Analysis,* Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 186-194.

U(11)-Al-Fe, U(16)-W-Al-Fe at $W/^{235}U$ = 2.7, U(21)-W-Al-Fe at $W/^{235}U$ = 4.8, U(93)-W-Al-Fe at $W/^{235}U$ = 5.9, U(93)-W-Al-Fe at $W/^{235}U$ = 4.8 and $C/^{235}U$ = 0 or 6.6, each in thick Al; U(93)-W-Al-Fe at $W/^{235}U$ = 4.8 and $O/^{235}U$ = 0 or 2.0, in various combinations of Al, Al_2O_3 and BeO (see II.A.4 and II.B.2).

W. G. Davey, "An Analysis of 23 ZPR-III Fast-Reactor Critical Experiments," Nucl. Sci. Eng. **19**, 259-273 (July 1964).

Recapitulation of data, corrections to homogeneous spheres (see II.B.2).

F. W. Thalgott, J. K. Long, W. G. Davey, W. Y. Kato, S. G. Carpenter, H. A. Morewitz, and G. H. Best, "Fast Critical Experiments and Their Analysis," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 124-136.

4.4 vol% U(93), 50% ss, 4.1% O, 36% Na; 58.9% U(16), 12.7% ss; 80.5% U(9.4), 9.3% ss; 14.9% U(39), 23% Al, 24% ss; 35.1% U(17), 18% Al, 14% ss; 25.2% U(19), 18% C, 17% ss, 36% Na; each in thick 83.3% U(0.23), 7.3% ss; also the ZPR-III data reported by Long et al. (see II.B.2 and II.C.2).

J. T. Mihalczo, "A Small Beryllium-Reflected UO_2 Assembly," Oak Ridge National Laboratory report ORNL-TM-655 (July 23, 1963).

1.14-cm-diam U(93.2)O_2 in 0.05-cm-thick ss, distributed in 26-cm-diam by 31-cm-high core, 7- to 11-cm-thick Be reflector.

J. T. Mihalczo, "A Small Graphite-Reflected UO_2 Critical Assembly, Part II," Oak Ridge National Laboratory report ORNL-TM-561 (April 8, 1963).

1.14-cm-diam U(93.2)O_2 in 0.05-cm-thick ss, distributed in 26-cm-diam by 31-cm-high core, 23- to 28-cm-thick graphite reflector.

J. T. Mihalczo, "A Small Graphite-Reflected UO_2 Assembly," Oak Ridge National Laboratory report ORNL-TM-450 (December 28, 1962).

1.14-cm-diam U(93.2)O_2 in 0.05-cm-thick ss, close packed in 22.3-cm-diam by 30.5-cm-high core, one graphite reflector from 13 to 19 cm thick, another from 5 to 24 cm thick.

J. K. Long, A. R. Baker, W. Gemmell, W. P. Keeney, R. L. McVean, and F. W. Thalgott, "Experimental Results on Large Dilute Fast Critical Systems with Metallic and Ceramic Fuels," *Physics of Fast and Intermediate Reactors,* Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 271-285.

~10 vol% U(93), 42.8% Al, 9.3% ss, or 74.5% C, 9.3% ss, or 81.0% ss, or 63.6% ss, 18.2% Na; ~80 vol% U(11.9, 9.4, 8.8), 9.3% ss; ~15 vol% U(31.2, 39.5), ~24% Al, 24.6% ss, 14.5 or 7.2% O; 15 vol% U(39), 23.5% Al, 24.5% ss; 15 vol% U(31.2), 25.5% Al, 10.6% C, 24.6% ss; each in thick U(0.23) with 2% Al, 7% ss (see II.B.2).

J. K. Long, W. B. Loewenstein, C. E. Branyan, G. S. Brunson, F. S. Kirn, D. Okrent, R. E. Rice, and F. W. Thalgott, "Fast Neutron Power Reactor Studies with ZPR-III," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 119-141.

~30 vol% U(47), 31% Al, 12% ss; ~50 vol% U(23), 22% Al, 14% ss; 15 vol% U(93), 31% Al, 28% ss; 70 vol% U(17), 19% ss; 81 vol% U(11.5), 9% ss; 60 vol% U(16), 9% ss, 21%C; 45 vol% U(21), 9% ss, 37% C; 30 vol% U(30), 9% ss, 53% C; 10 vol% U(93), 9% ss, 74% C; each in thick U(0.23) with 2% Al, 7% ss (see II.B.2).

C. L. Schuske, M. G. Arthur, A. Goodwin, Jr., A. N. Nickel, and D. F. Smith, "Sub-Critical Measurements on Parallelepipeds Containing U^{235} and Salt Eutectic," Rocky Flats Plant report RFP-89 (November 27, 1957).

14.75-in.-square by 0.105-in.-thick U(93) interleaved in various combinations with 30% Li_2CO_3-5% Na_2CO_3-65% K_2CO_3, solid U(93) plate, both reflected by the same salt.

7. Metal

J. T. Mihalczo, "Criticality of Graphite- and Polyethylene-Reflected Uranium(93.2%)-Metal Cylinders and Annuli," Nucl. Sci. Eng. **49**, 489-504 (December 1972).

7- to 15-in.-o.d. cylinders and annuli (7- to 11-in.-i.d.) reflected by graphite to 18-in. thickness or thick polyethylene.

J. Phelps, H. Windsor, H. Takahashi, J. Conant, and K. Chandramoleswar, "Critical Experiments for the Brookhaven Pulsed Fast Reactor Study," Nucl. Sci. Eng. **49**, 274-300 (November 1972).

26 vol% 0.17-in.-diam U(93.16), 41% steel, 14% Al, 19% void, thick steel reflector.

D. C. Coonfield, G. Tuck, H. E. Clark, and B. B. Ernst, "Critical Mass Irregularity of Steel-Moderated Enriched Uranium Metal Assemblies with Composite Steel-Oil Reflectors," Nucl. Sci. Eng. **39**, 320-328 (March 1970).

U(93.2) shells surrounding 8-cm-diam steel sphere in 0- to 5-cm-thick steel immersed in oil (anomaly with 3-cm-thick steel); also RFP 1033, November 7, 1967, and RFP-1025, November 6, 1967.

G. Tuck, "Critical Masses of Spherical and Hemispherical Enriched Uranium Assemblies," J. Nucl. Energy **23**, 663-672 (December 1969).

U(93.1) shells surrounding 0- to 12-cm-diam oil or steel spheres (and hemispheres), oil reflector; also RFP-1025, November 6, 1967, and RFP-907, July 26, 1967.

G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory report LA-4208 (September 1969).

Benchmark assemblies: bare spheres of U(94), δ-Pu, ^{233}U, Pu-U(93), ^{233}U-U(93); U(93), δ-Pu, ^{233}U spheres in thick U(nat); α-Pu sphere in water; bare cylinders of Av. U(53.3), U(37.5), U(16.0), U(14.1), U(12.3), U(10.9); Av. U(16.2) cylinder in 3-in.-thick U(nat) (see II.B.2, II.D.4, II.F, and II.G).

D. W. Magnuson, "Critical Experiments with Enriched Uranium Metal-Polyethylene, -Plexiglas, and -Teflon Mixtures," Oak Ridge National Laboratory report ORNL-TM-2082 (February 1968).

U(93) slabs, 12.7 by 25.4 cm and 25.4 cm square, solid and interleaved in thicknesses of 0.12 to 1.4 cm, bare and polyethylene reflected: max. H/U = 5 for U-polyethylene; U-Plexiglas and U-Teflon only 25.4 cm square, unreflected (see II.A.3 and II.A.6).

R. E. Rothe, "Critical Masses for Partially Steel Reflected Enriched Uranium Metal Assemblies," Rocky Flats Plant report RFP-1021 (September 18, 1967).

U(93) hemispheres, spherical shells with combinations of air and steel inside and outside.

B. B. Ernst, "Critical Masses of Oil Reflected, Enriched Uranium Metal Assemblies with Polyurethane Centers," Rocky Flats Plant report RFP-1017 (September 6, 1967).

U(93) spheres, polyethylene in 0-, 4-, 8-, 12-in.-i.d. cavities, immersed in oil.

J. T. Mihalczo, "Uranium (93.2%) Metal Cylinders with Thin Stainless-Steel Reflectors," (Technical Note) Nucl. Sci. Eng. **25**, 444-445 (August 1966).

7-in.-diam cylinders with top and bottom reflectors of 0.5-, 1.0-, 2.0-in.-thick ss.

G. E. Hansen, D. P. Wood, and B. Pena, "Reflector Savings of Moderating Materials on Large Diameter U(93.2%) Slabs," Los Alamos Scientific Laboratory report LAMS-2744 (October 8, 1962).

15- and 21-in.-diam U(93) cylinders, bare, and reflected top and bottom with 2- to 10-in.

polyethylene, 6-in. water, Plexiglas, and paraffin, and 6- to 14-in.-graphite.

D. P. Wood and B. Pena, "Critical Mass Measurements of Oy and Pu Cores in Spherical Aluminum Reflectors," Los Alamos Scientific Laboratory report LAMS-2579 (November 2, 1961).

U(93.18) sphere in 2.6-in.-thick Al, δ-Pu sphere in 3.1-in.-thick Al (see II.D.4).

J. T. Mihalczo and J. J. Lynn, "Neutron Multiplication Experiments with Enriched Uranium Metal in Slab Geometry," Oak Ridge National Laboratory report ORNL-CF-61-4-33 (April 10, 1961).

5- by 5-in. to 25- by 25-in. U(93) slabs with Plexiglas, Be, graphite reflectors.

G. E. Hansen, D. P. Wood, and W. U. Geer, "Critical Masses of Enriched-Uranium Cylinders with Multiple Reflectors of Medium-Z Elements," Nucl. Sci. Eng. 8, 588-594 (December 1960).

15-in.-diam U(93.2) cylinders reflected on one or both ends by multiple layers of two or three of Cu, Fe, Zn, Ni, ss.

G. E. Hansen, H. C. Paxton, and D. P. Wood, "Critical Plutonium and Enriched-Uranium-Metal Cylinders of Extreme Shape," Nucl. Sci. Eng. 8, 570-577 (December 1960).

15.0- and 3.24-in.-diam U(93), 6.0- and 2.25-in.-diam δ-Pu, thick reflectors of polyethylene, graphite, water; 15.0-in. U(93) also bare and with various thicknesses of Be (see II.D.4).

G. E. Hansen, H. C. Paxton, and D. P. Wood, "Critical Masses of Oralloy in Thin Reflectors," Los Alamos Scientific Laboratory report LA-2203 (July 16, 1958).

5.25-in.-diam U(93.5) cylinders in 0.5- and 1.0-in. Be, graphite, Mg, Ti, steel, Cu, W alloy, U(nat), Ni, Co, Mo, Al_2O_3, Mo_2C, polyethylene; U(93.5) spheres in ~2- and ~4-in. Be, BeO, C, Fe, Ni, Cu, Zn, nickel silver, W alloy, Th, U(nat).

R. E. Donaldson and W. K. Brown, "Critical-Mass Determinations of Lead-Reflected Systems," Lawrence Livermore Laboratory report UCRL-5255 (June 9, 1958).

U(93.2) spheres in 17- and 9-cm-thick Pb, 9.88- and 11.17-cm-diam cylinders in 13-cm-thick Pb.

G. E. Hansen, "Properties of Elementary Fast-Neutron Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 84-88.

δ-Pu spheres, bare and U(nat) reflector; U(94) spheres, bare and U(nat) reflector; Av. U(53.5), U(37.5), U(29) bare cylinders; Av. U(16.2) cylinder, U reflector (see II.B.2 and II.D.4).

H. R. Ralston, "Critical Masses of Spherical Systems of Oralloy Reflected in Beryllium," Lawrence Livermore Laboratory report UCRL-4975 (October 10, 1957).

U(93) in 0.88-, 1.28-, 2.14-, 3.65-, 7.98-in.-thick Be.

J. C. Hoogterp, "Critical Masses of Oralloy Lattices Immersed in Water," Los Alamos Scientific Laboratory report LA-2026 (March 6, 1957).

0.5-, 1.0-in. cubes, 1/8-in.-diam rods of U(94) at various spacings; single water-reflected cube (see III.A.1).

R. E. Peterson and G. A. Newby, "An Unreflected U-235 Critical Assembly," Nucl. Sci. Eng. 1, 112-125 (May 1956).

Lady Godiva, a bare metal sphere, better specifications published later; also LA-1614, September 1953.

R. H. White, "Topsy, A Remotely Controlled Critical Assembly-Machine," Nucl. Sci. Eng. 1, 53-61 (March 1956).

^{235}U metal in thick U(nat) at 100%, 70%, 50% of full density and ^{235}U enrichment; ^{235}U metal in thick Ni; ~UH_3C in thick Ni; better specifications published later; also LA-1251, May 1, 1951 (see II.A.3 and II.B.2).

F. F. Hart, "Safety Tests for Melting and Casting Oralloy," Los Alamos Scientific Laboratory report LA-1623 (December 1953).

1.5-in.-thick circular U(~94) plate in thick paraffin, U(93.9) spheres in 2- to 17-in.-thick graphite.

G. E. Hansen and D. P. Wood, "Precision Critical-Mass Determinations for Oralloy and Plutonium in Spherical Tuballoy Tampers," Los Alamos Scientific Laboratory report LA-1356 deleted (February 1, 1952).

U(94) spheres in 0- to 9-in.-thick U(nat), δ-Pu sphere in 4.6-in.-thick U(nat) (see II.D.4).

E. C. Mallary, "Oralloy Cylindrical Shape Factor and Critical Mass Measurements in Graphite, Paraffin, and Water Tampers," Los Alamos Scientific Laboratory report LA-1305 (October 27, 1951).

U(93.9) metal spheres and cylinders (h/d = 0.08 to 4.4) in thick water, thick paraffin, 17-in.-thick graphite.

J. D. Orndoff and H. C. Paxton, "Measurements on Untamped Oralloy Assembly," Los Alamos Scientific Laboratory report LA-1209 (February 8, 1951).

Bare pseudosphere of U(93.5) at 18.5 g U/cm^3.

V. Josephson, R. W. Paine, Jr., and L. L. Woodward, "Oralloy Shape Factor Measurements," Los Alamos Scientific Laboratory report LA-1155 deleted (August 8, 1950).

U(93.5) cylinders, 2.5- to 7.5-in.-diam (h/d = 0.4 to 3.5), in 0- to 2-in. U(nat); pseudocylinders, 3.0- to 8.3-in.-diam (h/d = 0.18 to 3.1) in 8-in. U(nat).

V. Josephson, "Critical-Mass Measurements on Oralloy in Tuballoy and WC Tampers," Los Alamos Scientific Laboratory report LA-1114 deleted (May 2, 1950).

U(93.5) metal spheres or pseudospheres in 2-, 3-, 4-, 5-, 7-, 8-, 11-in.-thick U(nat), 1.9-, 2.9-, 4.5-, 6.5-in.-thick WC, 8-in.-thick Ni; parallelepipeds with height/base = 0.2 to 2.5 in 8-in.-thick U(nat).

8. Metal with Solution

R. E. Rothe and D. C. Hunt, "The Effect of Position on the Criticality of Uranium Spheres in Uranium Solution Cylinders," (Technical Note) Nucl. Sci. Eng. 54, 360-366 (July 1974).

U(93.16) metal in solution at ~11, 22, 96 g ^{235}U/liter; displacements up to ~0.85 half-height.

G. Tuck, H. E. Clark, and D. L. Alvarez, "Enriched Uranium Metal-Solution Systems Separated by Neutron Poisons," Nucl. Technol. 18, 216-224 (June 1973).

U(93.2) as metal sphere in uranyl-nitrate solution at 52 to 449 g U/liter, 26.5- and 38.4-cm-diam tanks, bare; nothing, 0.33-cm-thick mild steel or 1.02 wt% B in steel immediately surrounding sphere.

D. C. Hunt and R. E. Rothe, "Criticality Measurements on Uranium Metal Spheres Immersed in Solution," Nucl. Sci. Eng. 46, 76-87 (October 1971).

U(93.2) spheres in solution at 10.7 to 98 g ^{235}U/liter, 26.5-, 38.4-, 51.1-cm-diam cylindrical containers.

A. Goodwin, Jr., C. L. Schuske, and G. H. Bidinger, "Criticality Studies of Enriched Uranium Metal in $UO_2(NO_3)_2$ Solutions," Rocky Flats Plant report RFP-182 (January 26, 1960).

0.060-in.-thick by 5.62-in.-diam U(~90) disks, combinations spaced in solutions at 0, 95, 287 g ^{235}U/liter.

C. L. Schuske, M. G. Arthur, and D. F. Smith, "Neutron Multiplication Measurements on Oralloy Slabs Immersed in Solutions. Part II," Rocky Flats Plant report RFP-69 (October 25, 1956).

Critical thicknesses of 5- by 8-in. U(93) slab in $U(93)O_2(NO_3)_2$ solutions up to 157 g ^{235}U/liter.

C. L. Schuske, M. G. Arthur, and D. F. Smith, "Neutron Multiplication Measurements on Oralloy Slabs Immersed in Solutions," Rocky Flats Plant report RFP-66 (August 6, 1956).

Critical thicknesses of 10- by 16-in. U(93) slab in $U(93)O_2(NO_3)_2$ solutions up to 16 g ^{235}U/liter.

B. U(10 to 90)

1. Solutions (H_2O and D_2O), Hydrogenous Mixtures

T. L. Andersson, L. Björéus, F. Hellstrand, H. Häggblom, S-O. London, L. I. Tirén, and J. Kockum, "Experimental and Theoretical Work at

the Zero-energy Fast Reactor FRO," *Fast Critical Experiments and Their Analysis,* Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 159-185.

U(20)-ss, U(20)-ss-graphite at C/^{235}U = 4.3, U(20)-ss-graphite-polyethylene at C/^{235}U = 5.6 and H/^{235}U = 1.2, each in 35-cm-thick Cu-ss; U(20)-ss in ~12-cm-thick U(nat) (see II.B.2).

R. C. Lane, "Measurements of the Critical Parameters of Under-Moderated Uranium-Hydrogen Mixtures at Intermediate Enrichments," *Criticality Control of Fissile Materials,* Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 177-190.

U(30.14)O_2-wax, H/^{235}U = 8 to 80, bare, reflectors of Perspex, polyethylene, beech with and without Cd, concrete with and without Cd; U(37.67) metal, reflectors of polyethylene, beech with and without Cd (see II.B.2).

B. G. Dubovsky, A. V. Kamaev, V. V. Orlov, G. M. Vladykov, V. N. Gurin, F. M. Kuznetsov, V. P. Kochergin, I. P. Markelov, G. A. Popov, and V. J. Sviridenko, "The Critical Parameters of Aqueous Solutions of $UO_2(NO_3)_2$ and Nuclear Safety," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 254-263.

32 to 287 g U(90)/liter as parallelepipeds, bare, water, and water-steel reflected; also U(10), U(5) cylinders (see II.A.1 and II.C.1).

J. W. Weale, M. H. McTaggart, H. Goodfellow, and W. J. Paterson, "Operation Experience with the Zero-Energy Fast Reactor Vera," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964), Vol. I, pp. 159-195.

U(93)-ss-graphite at C/^{235}U = 7.8 or 10.7, U(93)-ss-graphite-polyethylene at C/^{235}U = 4.4 to 6.3 and H/^{235}U = 1.0, U(32)-ss-graphite at C/^{235}U = 5.8, U(32)-ss-graphite-polyethylene at C/^{235}U = 6.3 and H/^{235}U = 1.0, Pu-Cu-ss-graphite at C/Pu = 3.0 to 6.0; each in thick U(nat)-ss (see II.A.3, II.A.4, II.B.2, and II.D.3).

A. F. Thomas, "Interim Note on Critical Mass Measurements with 30% Enriched Uranium/Hydrogen Mixtures at Low H:U Ratios," United Kingdom Atomic Energy Authority report SNA/NM/A/13/61 (October 3, 1961).

Near-cubic U(30)O_2-paraffin, H/^{235}U = 40 (bare), 8.3, 16.5 reflected by Perspex, polyethylene.

J. R. Harrison, M. F. Smith, W. G. Clarke, A. M. Mills, and J. A. Dyson, "Critical Assemblies with Heavy Water Solutions of Uranyl Fluoride (H.A.Z.E.L.), Part II Physics," United Kingdom Atomic Energy Authority report AERE R/R 2703 (November 1958).

U(45.5)O_2F_2-D_2O solution, 2-ft-diam tank in 18-in. lateral graphite, D/^{235}U = 1940 to 6720.

W. G. Clarke, C. C. Horton, and M. F. Smith, "Critical Assemblies of Aqueous Uranyl Fluoride Solutions, Part I, Experimental Techniques," United Kingdom Atomic Energy Authority report AERE R/R 2051 (September 20, 1956).

U(44.6) or ^{233}U as UO_2F_2 solutions, 12-in.-diam cylinder, bare and thick lateral water reflector, H/(^{235}U or ^{233}U) = 250 to 850 (see II.G).

C. K. Beck, A. D. Callihan, and R. L. Murray, "Critical Mass Studies, Part II," Oak Ridge Gaseous Diffusion Plant report K-126 (January 23, 1948).

1-in. cubes of 64.8 wt% U(29.8), 31.1% F, 3.3% C, 0.1% O, 0.7% Al interspersed with 0.5- or 1.0-in. polyethylene, Av. H/^{235}U = 8 to 224, bare and paraffin reflected; effects of inhomogeneity, shape, core density.

C. P. Baker and M. G. Holloway, "Critical Masses of Enriched Uranium Hydrides and Some Related Measurements," Los Alamos Scientific Laboratory report LA-618 (February 3, 1947).

U(~75) $H_{10}C_4$ blocks (0.5-in. min), undiluted cube or pseudosphere, bare, and in 6- and 12-in. BeO, 6.5-in. U(nat), 4.5-in. WC, 6.5-in. Fe, also some cores diluted with polyethylene.

A. H. Snell, "Critical Experiments of Fluorinated and Hydrogenated Mixtures Containing Enriched Uranium," Clinton Laboratories report MonP-48 (January 22, 1946).

1-in. cubes of U(24)$O_{2.83}C_{5.30}F_{3.60}Al_{0.4}$ interspersed and reflected with polyethylene (6-in. refl) at Av. H/U = 30.9, 15.1, 11, 7.5.

L. D. P. King, "Critical Assemblies, Chapter 4, Water Boilers," Los Alamos Scientific Laboratory report LA-1034 (December 19, 1947).

U(14.7)O_2SO_4 solution at H/^{235}U = 632 in 15-liter sphere, 12-in.-thick BeO reflector.

C. P. Baker, H. K. Daghlian, G. Friedlander, M. G. Holloway, D. W. Kerst, and R. E. Schreiber, "Water Boiler," Los Alamos Scientific Laboratory report LA-134 (September 4, 1944).

U(14.7)O_2SO_4 solution in 15-liter sphere, 38 g ^{235}U/liter in ~12-in. BeO reflector, 51 g ^{235}U/liter in graphite.

2. Metal, Nonhydrogenous Mixtures

E. A. Fischer, "Integral Measurements of the Effective Delayed Neutron Fractions in the Fast Critical Assembly SNEAK," Nucl. Sci. Eng. **62**, 105-116 (January 1977).

75.7-cm-diam by 70.1-cm-high core, 0.90 g PuO_2/cm^3, 6.64 g U(1.8)O_2/cm^3, 0.05 g Al/cm^3, 1.31 g ss/cm^3; 57.3-cm-diam by 44.0-cm-high core (two zone), ~1.2 g PuO_2/cm^3, ~3.6 g UO_2/cm^3, ~0.5 g C/cm^3, ~1.1 g ss/cm^3; 72.4-cm-diam by 60.0-cm-high core (two zone), ~0.9 g PuO_2/cm^3, ~2.8 g UO_2/cm^3, ~0.3 g Na/cm^3, ~1.4 g ss/cm^3; 75.2-cm-diam by 60.0-cm-high core (two zone), ~4.3 g (U+UO_2)/cm^3 [U(30.2)], ~0.06 g C/cm^3, ~0.3 g Na/cm^3, ~1.5 g ss/cm^3; all in 30-cm-thick reflector, 15.8 g U(0.4)/cm^3, 0.57 g ss/cm^3 (see II.E).

P. I. Amundson, E. F. Bennet, S. G. Carpenter, W. Y. Kato, L. G. LeSage, R. A. Lewis, R. G. Palmer, C. E. Till, A. Travelli, B. A. Zolotar, C. E. Clifford, M. J. Driscoll, and Y. D. Harker, "U. S. Fast Integral Experiments Program," Proc. Int. Symp. Physics of Fast Reactors, Tokyo, October 16-19, 1973 (Published by Committee for the International Symposium on Physics of Fast Reactors, Power Reactor and Nuclear Fuel Development Corporation, Tokyo) Vol. I, pp. 431-463.

ZPR-6-6:4000-liter core of U(16.5)O_2-Na-ss in ~30-cm-thick U(0.2)-ss. ZPR-6-7:3100-liter PuO_2-U(0.2)O_2-Na-ss at U/Pu = 5.7, in 34-cm-thick U(0.2)-ss. ZPPR-2,3 with two-zone PuO_2-UO_2 cores also described (see II.D.3).

G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory report LA-4208 (September 1969).

Benchmark assemblies: bare spheres of U(94), δ-Pu, ^{233}U, Pu-U(93), ^{233}U-U(93); U(93), δ-Pu, ^{233}U spheres in thick U(nat); α-Pu sphere in water; bare cylinders of Av. U(53.3), U(37.5), U(16.0), U(14.1), U(12.3), U(10.9); Av. U(16.2) cylinder in 3-in.-thick U(nat) (see II.A.7, II.D.4, II.F, and II.G).

C. G. Chezem and E. J. Lozito, "Investigation of the Criticality of Low-Enrichment Uranium Cylinders," (Technical Note) Nucl. Sci. Eng. **33**, 139 (July 1968).

Interleaved 21-in.-diam plates of U(93.3) and U(nat), bare, averaging U(10.9), U(12.3), U(14.1), U(16.0).

G. K. Rusch, R. A. Karam, W. Y. Kato, and G. W. Main, "Physics Parameters of Large Dilute Uranium Carbide Cores," *Fast Critical Experiments and Their Analysis,* Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 231-236.

U(13)-Na-ss-graphite at C/^{235}U = 8.4, in 30-cm-thick U(0.2)-ss.

D. K. Butler, R. C. Doerner, and W. G. Knapp, "Measurements and Analysis of Al-, Al_2O_3-, and BeO-reflected Fast Critical Experiments," *Fast Critical Experiments and Their Analysis,* Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL 7320, pp. 186-194.

U(11)-Al-Fe, U(16)-W-Al-Fe at W/^{235}U = 2.7, U(21)-W-Al-Fe at W/^{235}U = 4.8, U(93)-W-Al-Fe at W/^{235}U = 5.9, U(93)-W-Al-Fe at W/^{235}U = 4.8 and C/^{235}U = 0 or 6.6, each in thick Al; U(93)-W-Al-Fe at W/^{235}U = 4.8 and O/^{235}U = 0 or 2.0, in various combinations of Al, Al_2O_3 and BeO (see II.A.4 and II.A.6).

T. L. Andersson, L. Björeus, F. Hellstrand, H. Häggblom, S-O. London, L. I. Tirén, and J. Kockum, "Experimental and Theoretical Work at the Zero-energy Fast Reactor FRO," *Fast Critical Experiments and Their Analysis,* Proc. Argonne

Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 159-185.

U(20)-ss, U(20)-ss-graphite at C/^{235}U = 4.3, U(20)-ss-graphite-polyethylene at C/^{235}U = 5.6 and H/^{235}U = 1.2, each in 35-cm-thick Cu-ss; U(20)-ss in ~12-cm-thick U(nat) (see II.B.1).

R. C. Lane and O. J. E. Perkins, "Measurement of the Critical Mass of 37-1/2% Enriched Uranium in Reflectors of Wood, Concrete, Polyethylene and Water," United Kingdom Atomic Energy Authority report AWRE NR 1/66 (February 1966).

Critical thicknesses of 20-cm.-square metal plates reflected by 20-cm-thick concrete and wood, with and without Cd, and polyethylene (also 15-cm and 30-cm square).

R. C. Lane, "Measurements of the Critical Parameters of Under-Moderated Uranium-Hydrogen Mixtures at Intermediate Enrichments," *Criticality Control of Fissile Materials,* Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 177-190.

U(30.14)O_2-wax, H/^{235}U = 8 to 80, bare, reflectors of Perspex, polyethylene, beech with and without Cd, concrete with and without Cd; U(37.67) metal, reflectors of polyethylene, beech with and without Cd (see II.B.1).

F. W. Thalgott, J. K. Long, W. G. Davey, W. Y. Kato, S. G. Carpenter, H. A. Morewitz, and G. H. Best, "Fast Critical Experiments and Their Analysis," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 124-136.

4.4 vol% U(93), 50% ss, 4.1% O, 36% Na; 58.9% U(16), 12.7% ss; 80.5% U(9.4), 9.3% ss; 14.9% U(39), 23% Al, 24% ss; 35.1% U(17), 18% Al, 14% ss; 25.2% U(19), 18% C, 17% ss, 36% Na; each in thick 83.3% U(0.23), 7.3% ss; also the ZPR-III data reported by Long et al. (see II.A.6 and II.C.2).

R. D. Smith, J. L. Rowlands, A. R. Baker, D. C. Smith, E. P. Hicks, J. E. Mann, and J. Weale, "Fast Reactor Physics, Including Results from UK Zero Power Reactors," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 90-111.

Pu-Cu-Ni-graphite at C/Pu = 0, 2.0, 4.0, 8.1, 12.2, 16.2, 24.0, 33, 64, 200, and 400, in thick graphite; U(12)-ss, U(14)-ss-graphite at C/^{235}U = 15.8, Pu-U(nat)-Cu-ss at U/Pu = 8.4, each in thick U(nat)-ss; also the VERA data reported by Weale et al. (see II.D.3).

W. G. Davey, "An Analysis of 23 ZPR-III Fast-Reactor Critical Experiments," Nucl. Sci. Eng. **19**, 259-273 (July 1964).

Recapitulation of data, corrections to homogeneous spheres (see II.A.6).

J. W. Weale, M. H. McTaggart, H. Goodfellow, and W. J. Paterson, "Operation Experience with the Zero-Energy Fast Reactor Vera," *Exponential and Critical Experiments,* Proc. Amsterdam Conf. (IAEA, Vienna, 1964), Vol. I, pp. 159-195.

U(93)-ss-graphite at C/^{235}U = 7.8 or 10.7, U(93)-ss-graphite-polyethylene at C/^{235}U = 4.4 to 6.3 and H/^{235}U = 1.0, U(32)-ss-graphite at C/^{235}U = 5.8, U(32)-ss-graphite-polyethylene at C/^{235}U = 6.3 and H/^{235}U = 1.0, Pu-Cu-ss-graphite at C/Pu = 3.0 to 6.0; each in thick U(nat)-ss (see II.A.3, II.A.4, II.B.1 and II.D.3).

J. R. Dominey, R. C. Lane, and A. F. Thomas, "Critical Mass Measurements with Thin Discs of 45.5% Enriched Uranium," United Kingdom Atomic Energy Authority report AWRE NR/A-1/62 (March 1962).

Pseudocircular metal slabs, 5.8-, 8.5-, 11.0-in. diam, bare, and reflected by ~6-in.-thick U(nat), Al, graphite, borated graphite, steel.

J. K. Long, A. R. Baker, W. Gemmell, W. P. Keeney, R. L. McVean, and F. W. Thalgott, "Experimental Results on Large Dilute Fast Critical Systems with Metallic and Ceramic Fuels," *Physics of Fast and Intermediate Reactors,* Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 271-285.

~10 vol% U(93), 42.8% Al, 9.3% ss, or 74.5% C, 9.3% ss, or 81.0% ss, or 63.6% ss, 18.2% Na; ~80 vol% U(11.9, 9.4, 8.8), 9.3% ss; ~15 vol% U(31.2, 39.5), ~24% Al, 24.6% ss, 14.5 or 7.2% O; 15 vol% U(39), 23.5% Al, 24.5% ss; 15 vol% U(31.2), 25.5% Al, 10.6% C, 24.6% ss; each in thick U(0.23) with 2% Al, 7% ss (see II.A.6 and II.C.2).

J. J. McEnhill and J. W. Weale, "Integral Experiments on Fast Systems of Plutonium, Uranium and Thorium," *Physics of Fast and Intermediate*

Reactors, Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 253-262.

Pu metal spheres, bare, and in U(nat), Fe, C; U(45.5) metal slabs, 11.6-, 16.9-, 22.1-in.-diam, bare, and in U(nat), C, steel, Al; U(92.9)-graphite core at C/^{235}U = 7.8, 27-cm-diam by 38-cm-high, U(nat) reflector (see II.A.4 and II.D.4).

J. K. Long, W. B. Loewenstein, C. E. Branyan, G. S. Brunson, F. S. Kirn, D. Okrent, R. E. Rice, and F. W. Thalgott, "Fast Neutron Power Reactor Studies with ZPR-III," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 119-141.

~30 vol% U(47), 31% Al, 12% ss; ~50 vol% U(23), 22% Al, 14% ss; 15 vol% U(93), 31% Al, 28% ss; 70 vol% U(17), 19% ss; 81 vol% U(11.5), 9% ss; 60 vol% U(16), 9% ss, 21%C; 45 vol% U(21), 9% ss, 37% C; 30 vol% U(30), 9% ss, 53% C; 10 vol% U(93), 9% ss, 74% C; each in thick U(0.23) with 2% Al, 7% ss (see II.A.6).

G. E. Hansen, "Properties of Elementary Fast-Neutron Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 84-88.

δ-Pu spheres, bare and U(nat) reflector; U(94) spheres, bare and U(nat) reflector; Av. U(53.5), U(37.5), U(29) bare cylinders; Av. U(16.2) cylinder, U reflector (see II.A.7 and II.D.4).

J. J. Neuer, "Critical Assembly of Uranium Metal at an Average U^{235} Concentration of 16-1/4%," Los Alamos Scientific Laboratory report LA-2085 (January 28, 1957).

Interleaved 15-in.-diam plates of U(93) and U(nat) in 3-in.-thick U(nat).

B. C. Cerutti, H. V. Lichtenberger, D. Okrent, R. E. Rice, and F. W. Thalgott, "ZPR-III, Argonne's Fast Critical Facility," Nucl. Sci. Eng. 1, 126-134 (May 1956).

EBR-II mockup: U(47), Al, ss, parallelepiped in U(depleted), Al, ss.

R. H. White, "Topsy, A Remotely Controlled Critical Assembly-Machine," Nucl. Sci. Eng. 1, 53-61 (March 1956).

^{235}U metal in thick U(nat) at 100%, 70%, 50% of full density and ^{235}U enrichment; ^{235}U metal in thick Ni; ~UH_3C in thick Ni; better specifications published later; also LA-1251, May 1, 1951 (see II.A.3 and II.A.7).

F. C. Beyer, R. H. Bryan, H. H. Hummel, D. H. Lennox, F. H. Martens, W. A. Reardon, N. Rosenzweig, A. B. Smith, and B. I. Spinrad, "The Fast Exponential Experiments," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 342-346.

Av. ~35 vol% U(12.8), U(16.7), U(24.2), 10.4% Fe, 30, 15, 0% Al.

H. C. Paxton, "Bare Critical Assemblies of Oralloy at Intermediate Concentrations of U-235," Los Alamos Scientific Laboratory report LA-1671 (May 1954).

10.5-in.-diam plates of U(93.4), 8-mm-thick, and U(nat), 6-mm-thick, interleaved to average U(53.5), U(37.5), U(29).

C. U(<10)

1. Solutions, Hydrogenous Mixtures

E. B. Johnson, "The Nuclear Criticality of Intersecting Cylinders of Aqueous Uranyl Fluoride Solutions," Oak Ridge Y-12 Plant report Y-DR-129 (October 31, 1974).

U(5)O_2F_2 solution at 745 to 911 g U/liter, 11-in. 30° intersection, 12.75-in. cross, water reflected.

S. J. Rafferty and J. T. Mihalczo, "Homogeneous Critical Assemblies of 2 and 3% Uranium-235-Enriched Uranium in Paraffin," Nucl. Sci. Eng. 48, 433-443 (August 1972).

U(2 or 3)F_4-paraffin compacts, H/^{235}U from 133 to 972, parallelepipeds bare and reflected with Plexiglas, paraffin, or polyethylene.

S. R. Bierman and G. M. Hess, "Minimum Critical ^{235}U Enrichment of Homogeneous Uranyl Nitrate," Oak Ridge Criticality Data Center report ORNL-CDC-5 (June 1968).

PCTR measurements on crystalline U(2.14 or 2.26)$O_2(NO_3)_2$ compacts, H/U = 3 to 12, give min. critical enrichment 2.10 wt% ^{235}U.

J. W. Webster and E. B. Johnson, "Criticality of a Single Unit of Aqueous Uranyl Fluoride Solution Enriched to 5% in ^{235}U," Oak Ridge National Laboratory report ORNL-TM-1195 (July 23, 1965).

$U(4.98)O_2F_2$ solution at $H/^{235}U$ = 496, bare 39.1-cm-diam cylinder, h_c = 101.7 cm.

B. G. Dubovsky, A. V. Kamaev, V. V. Orlov, G. M. Vladykov, V. N. Gurin, F. N. Kuznetsov, V. P. Kochergin, I. P. Markelov, G. A. Popov, and V. J. Sviridenko, "The Critical Parameters of Aqueous Solutions of $UO_2(NO_3)_2$ and Nuclear Safety," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 254-263.

32 to 287 g U(90)/liter as parallelepipeds, bare, water, and water-steel reflected; also U(10), U(5) cylinders (see II.A.1 and II.B.1).

J. T. Mihalczo and V. I. Neeley, "The Infinite Neutron Multiplication Constant of Homogeneous Hydrogen-Moderated 2.0 wt% U^{235}-Enriched Uranium," Nucl. Sci. Eng. **13**, 6-11 (May 1962).

k_∞ = 1.2 for 92.1 wt% $U(2)F_4$-7.9 wt% paraffin, measured in PCTR.

V. I. Neeley, J. A. Berberet, and R. H. Masterson, "k_∞ of Three Weight Per Cent U^{235} Enriched UO_3 and $UO_2(NO_3)_2$ Hydrogenous Systems," Hanford Atomic Products Operation report HW-66882 (September 1961).

PCTR gives k_∞ = 1 at H/U = 45 for $U(3.04)O_3$, H/U = 31 for $U(3.04)O_2(NO_3)_2$.

V. I. Neeley and H. E. Handler, "Measurement of Multiplication Constant for Slightly Enriched Homogeneous UO_3-Water Mixtures and Minimum Enrichment for Criticality," Hanford Atomic Products Operation report HW-70310 (August 21, 1961).

U(1.01), U(1.07), U(1.16) at H/U = 3.5 to 7.5.

J. T. Mihalczo, "Comparison of k_∞ Measurements in a Critical Assembly with k_∞ Measurements in the Physical Constants Testing Reactor," Oak Ridge National Laboratory report ORNL-CF-60-4-24 (May 3, 1960).

k_∞ 1.20 from $U(2)F_4$-paraffin assembly, 1.22 from PCTR.

A. Wattenberg, "Exponential Experiments with D_2O and Solutions of UO_2F_2," Clinton Laboratories report CP-3364 (November 1, 1945).

$U(nat)O_2F_2$-D_2O (99.8%) solution, 0.024 to 0.35 g UO_2F_2/liter, min. m_c(bare) ~3,000 kg U.

2. Metal, Nonhydrogenous Mixtures

C. G. Chezem and R. G. Steinke, "Low-Enrichment Uranium-Metal Exponential Experiments," (Technical Note) Nucl. Sci. Eng. **31**, 549-550 (March 1968).

Interleaved 15-in.-diam plates of U(93.3) and U(nat), bare, to average U(4.3), U(6.5), U(9.1); indicates k_∞ = 1 for U(5.3).

B. G. Dubovsky, A. V. Kamaev, V. V. Orlov, G. M. Vladykov, V. N. Gurin, F. M. Kuznetsov, V. P. Kochergin, I. P. Markelov, G. A. Popov, and V. J. Sviridenko, "The Critical Parameters of Aqueous Solutions of $UO_2(NO_3)_2$ and Nuclear Safety," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 254-263.

32 to 287 g U(90)/liter as parallelepipeds, bare, water, and water-steel reflected; also U(10), U(5) cylinders (see II.A.1 and II.B.1).

F. W. Thalgott, J. K. Long, W. G. Davey, W. Y. Kato, S. G. Carpenter, H. A. Morewitz, and G. H. Best, "Fast Critical Experiments and Their Analysis," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 124-136.

4.4 vol% U(93), 50% ss, 4.1% O, 36% Na; 58.9% U(16), 12.7% ss; 80.5% U(9.4), 9.3% ss; 14.9% U(39), 23% Al, 24% ss; 35.1% U(17), 18% Al, 14% ss; 25.2% U(19), 18% C, 17% ss, 36% Na; each in thick 83.3% U(0.23), 7.3% ss; also the ZPR-III data reported by Long et al. (see II.A.6 and II.B.2).

J. K. Long, A. R. Baker, W. Gemmell, W. P. Keeney, R. L. McVean, and F. W. Thalgott, "Experimental Results on Large Dilute Fast Critical Systems with Metallic and Ceramic Fuels," *Physics of Fast and Intermediate Reactors,* Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 271-285.

~10 vol% U(93), 42.8% Al, 9.3% ss, or 74.5% C, 9.3% ss, or 81.0% ss, or 63.3% ss, 18.2% Na; ~80 vol% U(11.9, 9.4, 8.8), 9.3% ss; ~15 vol% U(31.2, 39.5), ~24%·Al, 24.6% ss, 14.5 or 7.2% O; 15 vol% U(39), 23.5% Al, 24.5% ss; 15 vol% U(31.2), 25.5% Al, 10.6% C, 24.6% ss; each in thick U(0.23) with 2% Al, 7% ss (see II.A.6 and II.B.2).

J. J. Neuer and C. B. Stewart, "Preliminary Survey of Uranium Metal Exponential Columns," Los Alamos Scientific Laboratory report LA-2023 (October 31, 1956).

Interleaved 15-in.-diam plates of U(93) and U(nat) in 3-in.-radial U(nat), to average U(0.72), U(4.29), U(5.14), U(6.53), U(9.18); indicates $k_\infty = 1$ for U(5.4).

D. Pu

1. Solutions, Hydrogenous Compacts, Mixtures

C. R. Richey, "Reexamination of the Value for the Minimum Critical Concentration of Plutonium-239 in Water," (Technical Note) Nucl. Sci. Eng. **55**, 244-246 (October 1974).

PCTR data now lead to minimum critical concentration of 7.2 g ^{239}Pu/liter.

R. C. Lloyd and E. D. Clayton, "The Criticality of High Burnup Plutonium," Nucl. Sci. Eng. **52**, 73-75 (September 1973).

Pu(41% ^{239}Pu) solution, 40 to 140 g Pu/liter, in 61-cm-diam cylinder with partial water reflector.

R. C. Lloyd, E. D. Clayton, L. E. Hansen, and S. R. Bierman, "Criticality of Plutonium Nitrate Solutions in Slab Geometry," Nucl. Technol. **18**, 225-230 (June 1973).

58 to 412 g Pu (4.6, 18.4, 23.2 wt% ^{240}Pu)/ liter, acid molarity from 1.6 to 5.0; 42-in.-square slabs from 3- to 9-in. thick, 0.062-in.-ss wall, internal ss "egg-crate," bare, thick water, 1-in. Plexiglas reflectors.

S. R. Bierman and E. D. Clayton, "Critical Experiments with Homogeneous PuO_2-Polystyrene at 50 H/Pu," Nucl. Technol. **15**, 5-13 (July 1972).

18.5% ^{240}Pu, parallelepipeds, near-equilateral bare, squat Plexiglas reflected.

L. E. Hansen, E. D. Clayton, R. C. Lloyd, S. R. Bierman, and R. D. Johnson, "Critical Parameters of Plutonium Systems. Part I: Analysis of Experiments," Nucl. Appl. **6**, 371-380 (April 1969).

Experimental slab data for $Pu(NO_3)_4$ solutions at 58, 202, 284 g Pu/liter, adjusted to infinite bare and water-reflected slabs.

S. R. Bierman, L. E. Hansen, R. C. Lloyd, and E. D. Clayton, "Critical Experiments with Homogeneous PuO_2-Polystyrene at 5 H/Pu," Nucl. Appl. **6**, 23-26 (January 1969).

Bare and Plexiglas-reflected parallelepipeds, near-equilateral and squat.

R. C. Lloyd, C. R. Richey, E. D. Clayton, and D. R. Skeen, "Criticality Studies with Plutonium Solutions," Nucl. Sci. Eng. **25**, 165-173 (June 1966).

$Pu(NO_3)_4$ solutions, 24 to 435 g Pu/liter, in 11.5-, 14-, 15.2-in.-diam spheres, water, paraffin, ss, concrete reflectors (one bare), effect of spaced concrete.

J. G. Bruna, J. P. Brunet, R. Caizergues, C. Clouet d'Orval, and P. Verriere, "Results of Homogeneous Critical Experiments Carried Out with ^{239}Pu, ^{235}U, and ^{233}U," (in French) *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 235-248.

ALECTO at Saclay: 25- to 42-cm-diam cylinders, ^{239}Pu-, ^{235}U-, ^{233}U-nitrate solutions, 15 to 18 g Pu/liter, 30 to 300 g ^{235}U/liter, 25 to 250 g ^{233}U/liter, bare, water reflector (see II.A.1 and II.G).

C. Clouet d'Orval, E. Deilgat, M. Houelle, and P. Lécorché, "Experimental Research in France on Criticality Problems," (in French) *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 193-213.

Valduc results: Pu solutions, 20 to 190 g Pu/liter, 30-cm-diam cylinder; 150-cm by 120-cm by 10-cm-thick slab; 50-cm-o.d. by 35-cm-i.d., 50-cm-o.d. by 30-cm-i.d., 50-cm-o.d. by 20-cm-i.d. annuli; two interacting 50-cm-o.d. by 30-cm-i.d. annuli; reflectors various combinations of air, water, with and without Cd (see IV.B).

C. R. Richey, J. D. White, E. D. Clayton, and R. C. Lloyd, "Criticality of Homogeneous Plutonium Oxide-Plastic Compacts at H:Pu = 15," Nucl. Sci. Eng. **23**, 150-158 (October 1965).

Plexiglas-reflected shapes from columns to slabs (2.2 and 8.0% ^{240}Pu).

D. Breton, P. Lécorché, and C. Clouet d'Orval, "Criticality Studies," (in French) Proc. Intern Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 234-243.

Saclay: solutions at 60 g Pu/liter and ~30 to 100 g ^{235}U/liter as U(90) in bare 42-cm-diam cylinder and water-reflected 30-cm-diam cylinder; also spaced reflectors, interaction of two 10-cm-diam cylinders with one at 30-cm-diam; Dijon: Pu solution in 50-cm-o.d. by 30-cm-i.d. annulus, interaction of two annuli (see II.A.1 and IV.B).

R. H. Masterson, J. D. White, and T. J. Powell, "The Limiting Critical Concentrations for Pu^{239} and U^{235} in Aqueous Solutions," Hanford Atomic Products Operation report HW-77089, (March 27, 1963).

Limiting critical concentration of $Pu(NO_3)_4$ solution 8.0 g Pu/liter, of $U(93)O_2F_2$ solution 12.0 g ^{235}U/liter, from PCTR measurements (see II.A.1).

J. Bruna, J. P. Brunet, R. Caizergues, C. Clouet d'Orval, J. Kremser et al., "ALECTO—Criticality Experiment on a Plutonium Solution. Experimental Results. Vessel Number 1 (ϕ = 324 mm)," (in French) French Commissariat of Atomic Energy report CEA-2274 (1963).

$Pu(NO_3)_2$ solutions at 23.5 to 45.5 g Pu/liter, lateral and bottom reflector of thick water.

G. H. Bidinger, C. L. Schuske, and D. F. Smith, "Plutonium Plexiglas Assemblies, Part II," Rocky Flats Plant report RFP-190 (July 27, 1960).

12.5- or 18.0-in.-diam δ-Pu disks, 0.024- to 0.120-in.-thick, interleaved with Plexiglas at H/Pu = 18 to 94, bare and Plexiglas reflected.

C. L. Schuske, G. H. Bidinger, A. Goodwin, Jr., and D. F. Smith, "Plutonium Plexiglas Assemblies," Rocky Flats Plant report RFP-178 (January 20, 1960).

Interleaved 12.5-in.-diam disks of δ-Pu and Plexiglas, 0.632-in-thick Pu, 0.115-in.-thick Plexiglas, bare (other assemblies too subcritical).

J. Bertrand, P. Bonnaure, C. Clouet d'Orval, J. Corpel, J. de Lamare, P. Lecoustey, I. Prevot, R. Roche, M. Sauve, J. Tachon, and G. Vendryes, "'Proserpine,' a Homogeneous Critical Experiment with Plutonium," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 539-562.

Pu sulphate solution ~30 g Pu/liter, 25-cm-diam by 30-cm-high tank in 27.5-cm BeO surrounded by 50-cm graphite.

C. C. Horton and J. D. McCullen, "Plutonium-Water Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 156-161.

Pu nitrate solutions at H/Pu = 397, 655, 892, in 30.5-cm-diam tank, lateral water reflector with and without Cd.

F. E. Kreusi, J. O. Erkman, and D. D. Lanning, "Critical Mass Studies of Plutonium Solutions," Hanford Atomic Products Operation report HW-24514 (May 19, 1952).

Pu nitrate solutions, 12-, 13-, 14-, 15-in.-diam water-reflected spheres, 16-, 18-, 20-in.-diam bare spheres, 9-, 10-, 11-, 12-in.-diam water-reflected cylinders; Pu and nitrate concentrations varied.

B. T. Feld and L. Slotin, "Critical Mass of a Water Tamped 49 Solution," Los Alamos Scientific Laboratory report LA-272 (May 14, 1945).

485 g ^{239}Pu as 11.35 liters of $Pu(NO_3)_4$ solution in glass-Plexiglas containers, subcritical in water, critical with ~2-in. layer of BeO blocks in the water.

2. Poisoned Solutions, Mixtures

R. C. Lloyd, S. R. Bierman, and E. D. Clayton, "Criticality of Plutonium Nitrate Solutions Containing Borated Raschig Rings," Nucl. Sci. Eng. **50**, 127-134 (February 1973).

Glass rings with 0.5 or 4.0 wt% B, ss rings with 1 wt% B, in solutions from 63 to 412 g Pu/liter.

R. C. Lloyd, E. D. Clayton, and L. E. Hansen, "Criticality of Plutonium Nitrate Solutions Containing Soluble Gadolinium," Nucl. Sci. Eng. 48, 300-304 (July 1972).

24-in.-diam water-reflected cylinder, 116 and 363 g Pu/liter, ≤20 g Gd/liter.

F. Barbry, J. Bouly, R. Caizergues, E. Deilgat, M. Houelle, and P. Lécorché, "Theoretical and Experimental Research into the Heterogeneous Poisoning of Fissile Matter Solutions by Tubes or Annuli of Borosilicate Glass," (in French) French Commissariat of Atomic Energy report CEA-R-3931 (December 1969).

30-, 40-mm-o.d. tubes, 30-mm-o.d. rings of 2-, 2.5-mm-thick borosilicate glass, in Pu nitrate solutions at 99 to 356 g Pu/liter.

G. H. Bidinger, C. L. Schuske, and D. F. Smith, "Nuclear Safety Experiments on Plutonium and Enriched Uranium Hydrogen Moderated Assemblies Containing Boron," Rocky Flats Plant report RFP-201 (October 13, 1960).

12.5-in.-diam by 0.058-in.-thick, 18.0-in.-diam by 0.016-in.-thick δ-Pu interleaved with Plexiglas and B-plastic, H/Pu = 13 to 99, B/Pu = 0.021, 0.18, 0.36 (no precision index).

3. Nonhydrogenous Mixtures

P. I. Amundson, E. F. Bennett, S. G. Carpenter, W. Y. Kato, L. G. LeSage, R. A. Lewis, R. G. Palmer, C. E. Till, A. Travelli, B. A. Zolotar, C. E. Clifford, M. J. Driscoll, and Y. D. Harker, "U. S. Fast Integral Experiments Program," Proc. Int. Symp. Physics of Fast Reactors, Tokyo, October 16-19, 1973 (Published by Committee for the International Symposium on Physics of Fast Reactors, Power Reactor and Nuclear Fuel Development Corporation, Tokyo) Vol. I, pp. 431-463.

ZPR-6-6:4000-liter core of U(16.5)O_2-Na-ss in ~30-cm-thick U(0.2)-ss. ZPR-6-7:3100-liter PuO_2-U(0.2)O_2-Na-ss at U/Pu = 5.7, in 34-cm-thick U(0.2)-ss. ZPPR-2,3 with two-zone PuO_2-UO_2 cores also described (see II.B.2).

S. R. Bierman and E. D. Clayton, "Critical Experiments with Unmoderated Plutonium Oxide," Nucl. Technol. 11, 185-190 (June 1971).

~26-, 31-, 41-cm-square slabs of Pu(18% ^{240}Pu)O_2 at H/Pu = 0.04, bare, Plexiglas reflector.

J. M. Stevenson, J. M. Gasidlo, V. C. Rogers, G. G. Simons, and R. O. Vosburgh, "Experimental Results for ZPR-3 Assemblies 58 and 59," Argonne National Laboratory report ANL-7695 (April 1970).

Pu-graphite-Al-ss at C/Pu = 26.7, in thick U(0.22)-ss or thick Pb-ss.

J. Adamson, R. M. Absalom, A. R. Baker, G. Ingram, S. K. I. Pattenden, and J. M. Stevenson, "Zebra 6: A Dilute Plutonium-fuelled Assembly," *Fast Critical Experiments and Their Analysis*, Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 216-230.

Pu-U(nat)-graphite-Al-ss-Cu-Na or void at C/Pu = 14.5 and U/Pu = 1.6, in thick U(nat)-graphite-ss at C/U = 0.9.

A. M. Broomfield, P. I. Amundson, W. G. Davey, J. M. Gasidlo, A. L. Hess, W. P. Keeney, and J. K. Long, "ZPR-3 Assembly 48: Studies of a Dilute Plutonium-fueled Assembly," *Fast Critical Experiments and Their Analysis*, Proc. Argonne Intern. Conf., October 10-13, 1966, Argonne National Laboratory report ANL-7320, pp. 205-215.

Pu-U(0.21)-graphite-Na-ss at C/Pu = 11.8 and U/Pu = 4.2 in ~12-in.-thick U(0.21)-ss.

R. D. Smith, J. L. Rowlands, A. R. Baker, D. C. Smith, E. P. Hicks, J. E. Mann, and J. Weale, "Fast Reactor Physics, Including Results from UK Zero Power Reactors," Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 90-111.

Pu-Cu-Ni-graphite at C/Pu = 0, 2.0, 4.0, 8.1, 12.2, 16.2, 24.0, 33, 64, 200, and 400, in thick graphite; U(12)-ss, U(14)-ss-graphite at C/^{235}U = 15.3, Pu-U(nat)-Cu-ss at U/Pu = 8.4, each in thick

U(nat)-ss; also the VERA data reported by Weale et al. (see II.B.2).

D. H. Carter, W. G. Clarke, C. Hunt, J. Marshall, D. B. McCulloch, J. E. Sanders, and C. R. Symons, "Measurements of Buckling and Relative Reaction Rates in Some Plutonium-Graphite Assemblies," J. Nucl. Energy **18**, 105-124 (January 1964).

0.2-in.-thick Pu-Al at Al/Pu = 120, interleaved with graphite, C/^{239}Pu = 2420 to 14520; also U(93) with graphite, C/^{235}U = 3490, Al/^{235}U = 41; buckling to ~0.3% (see II.A.4).

J. W. Weale, M. H. McTaggart, H. Goodfellow, and W. J. Paterson, "Operation Experience with the Zero-Energy Fast Reactor Vera," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964), Vol. I, pp. 159-195.

U(93)-ss-graphite at C/^{235}U = 7.8 or 10.7, U(93)-ss-graphite-polyethylene at C/^{235}U = 4.4 to 6.3 and H/^{235}U = 1.0, U(32)-ss-graphite at C/^{235}U = 5.8, U(32)-ss-graphite-polyethylene at C/^{235}U = 6.3 and H/^{235}U = 1.0, Pu-Cu-ss-graphite at C/Pu = 3.0 to 6.0; each in thick U(nat)-ss (see II.A.3, II.A.4, II.B.1, and II.B.2).

D. P. Wood, C. C. Byers, and L. C. Osborn, "Critical Masses of Cylinders of Plutonium Diluted with Other Materials," Nucl. Sci. Eng. **8**, 578-587 (December 1960).

6-in.-diam δ-Pu interleaved with air, steel, Al, Th, U(depleted), in 0-, 2-, 4.5-, 7.5-in.-thick U(nat) or Th.

A. Goodwin, Jr., and C. L. Schuske, "Plutonium Graphite Assemblies, Part II," Rocky Flats Plant report RFP-158 (August 10, 1959).

~13.25-in.-diam δ-Pu, 0.34- to 0.50-in.-thick, interleaved with 14-in.-diam graphite, 1- to 2-in.-thick.

4. Metal

C. L. Schuske and D. Dickinson, "Criticality Design of a Large-Capacity Plutonium Melting Crucible," Nucl. Technol. **25**, 72-82 (January 1975).

12.7-cm-square δ-Pu slab, 10.1-cm-thick Plexiglas reflector.

D. C. Hunt and M. R. Boss, "Plutonium Metal Criticality Measurements," J. Nucl. Energy **25**, 241-251 (June 1971).

α-Pu spheres (and hemispheres) in 0- to 5-cm-thick steel with and without oil reflector.

D. B. Smith and W. U. Geer, "Critical Mass of a Water-Reflected Plutonium Sphere," Nucl. Appl. Technol. **7**, 405-408 (November 1969).

Precision critical specifications for α-Pu.

G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory Report LA-4208 (September 1969).

Benchmark assemblies: bare spheres of U(94), δ-Pu, ^{233}U, Pu-U(93), ^{233}U-U(93); U(93), δ-Pu, ^{233}U spheres in thick U(nat); α-Pu sphere in water; bare cylinders of Av. U(53.3), U(37.5), U(16.0), U(14.1), U(12.3), U(10.9); Av. U(16.2) cylinder in 3-in-thick U(nat) (see II.A.7, II.B.2, II.F, and II.G).

C. Clair, "Neutron Properties of RACHEL Critical Assembly," (in French) *Physics of Fast and Intermediate Reactors*, Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 321-325.

δ-Pu sphere in 9.3-cm-thick U(nat).

J. J. McEnhill and J. W. Weale, "Integral Experiments on Fast Systems of Plutonium, Uranium and Thorium," *Physics of Fast and Intermediate Reactors*, Proc. Vienna Conf. (IAEA, Vienna, 1962) Vol. I, pp. 253-262.

Pu metal spheres, bare, and in U(nat), Fe, C; U(45.5) metal slabs, 11.6-, 16.9-, 22.1-in.-diam, bare, and in U(nat), C, steel, Al; U(92.9)-graphite core at C/^{235}U = 7.8, 27-cm-diam by 38-cm-high, U(nat) reflector (see II.A.4 and II.B.2).

D. P. Wood and B. Pena, "Critical Mass Measurements of Oy and Pu Cores in Spherical Aluminum Reflectors," Los Alamos Scientific Laboratory report LAMS-2579 (November 2, 1961).

U(93.18) sphere in 2.6-in.-thick Al, δ-Pu sphere in 3.1-in.-thick Al (see II.A.7).

C. L. Schuske, D. F. Smith, and C. L. Bell, "Plexiglas Reflected Assemblies of Plutonium," Rocky Flats Plant report RFP-213 (January 10, 1961).

δ-Pu in 4-in. Plexiglas, 20-in. square, ~7.2-in. square, 5.0-in. square, ~3.89-in. diam, 12.54-in. diam, 2.5 by 2.75 in., 2.75 by 5.0 in., critical heights ±10%.

E. A. Plassmann and D. P. Wood, "Critical Reflector Thickness for Spherical U^{233} and Pu^{239} Systems," Nucl. Sci. Eng. 8, 615-620 (December 1960).

8.39-kg Pu and 7.60- or 10.01-kg ^{233}U in U(93), Be, W alloy, U(nat) (see II.F and II.G).

G. E. Hansen, H. C. Paxton, and D. P. Wood, "Critical Plutonium and Enriched-Uranium-Metal Cylinders of Extreme Shape," Nucl. Sci. Eng. 8, 570-577 (December 1960).

15.0- and 3.24-in.-diam U(93), 6.0- and 2.25-in.-diam δ-Pu, thick reflectors of polyethylene, graphite, water; 15.0-in. U(93) also bare and with various thicknesses of Be (see II.A.7).

G. A. Jarvis, G. A. Linenberger, J. D. Orndoff, and H. C. Paxton, "Two Plutonium-Metal Critical Assemblies," Nucl. Sci. Eng. 8, 525-531 (December 1960).

δ-Pu spheres, bare, in thick U(nat), also LA-2044, October 17, 1956.

H. R. Ralston, "Critical Parameters of Spherical Systems of Alpha-Phase Plutonium Reflected by Beryllium," Lawrence Livermore Laboratory report UCRL-5349 (September 10, 1958).

2.5- to 5.4-kg spheres in 32.0- to 5.2-cm Be.

G. E. Hansen, "Properties of Elementary Fast-Neutron Critical Assemblies," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 84-88.

δ-Pu spheres, bare and U(nat) reflector; U(94) spheres, bare and U(nat) reflector; Av. U(53.5), U(37.5), U(29) bare cylinders; Av. U(16.2) cylinder, U reflector (see II.A.7 and II.B.2).

F. A. Kloverstrom, "Spherical and Cylindrical Plutonium Critical Masses," Lawrence Livermore Laboratory report UCRL-4957 (September 1957).

δ-phase Pu, 7.4-, 10.8-kg spheres in U(nat), Be, C, Ti; 8.2-, 9.9-, 13.8-cm-diam cylinders in U(nat), Be, C, steel, polyethylene.

G. E. Hansen and D. P. Wood, "Precision Critical-Mass Determinations for Oralloy and Plutonium in Spherical Tuballoy Tampers," Los Alamos Scientific Laboratory report LA-1356 deleted (February 1, 1952).

U(94) spheres in 0- to 9-in.-thick U(nat), δ-Pu sphere in 4.6-in.-thick U(nat) (see II.A.7).

E. PuO_2-UO_2 Mixtures

E. A. Fischer, "Integral Measurements of the Effective Delayed Neutron Fractions in the Fast Critical Assembly SNEAK," Nucl. Sci. Eng. **62**, 105-116 (January 1977).

75.7-cm-diam by 70.1-cm-high core, 0.90 g PuO_2/cm^3, 6.64 g $U(1.8)O_2/cm^3$, 0.05 g Al/cm^3, 1.31 g ss/cm^3; 57.3-cm-diam by 44.0-cm-high core (two zone), ~1.2 g PuO_2/cm^3, ~3.6 g UO_2/cm^3, ~0.5 g C/cm^3, ~1.1 g ss/cm^3; 72.4-cm-diam by 60.0-cm-high core (two zone), ~0.9 g PuO_2/cm^3, ~2.8 g UO_2/cm^3, ~0.3 g Na/cm^3, ~1.4 g ss/cm^3; 75.2-cm-diam by 60.0-cm-high core (two zone), ~4.3 g $(U + UO_2)/cm^3$ [U(30.2)], ~0.06 g C/cm^3, ~0.3 g Na/cm^3, ~1.5 g ss/cm^3; all in 30-cm-thick reflector, 15.8 g $U(0.4)/cm^3$, 0.57 g ss/cm^3 (see II.B.2).

S. R. Bierman and E. D. Clayton, "Critical Experiments with Low-Moderated Homogeneous Mixtures of Plutonium and Uranium Oxides Containing 8, 15, and 30 wt% Plutonium," Nucl. Sci. Eng. **61**, 370-376 (November 1976).

PuO_2-U(depleted)O_2-polystyrene parallelepipeds, bare, Plexiglas reflected; 29.3 wt% Pu in Pu + U at H/(Pu + U) = 2.8, 15.0% Pu at H/(Pu + U) = 2.86, 8.1% Pu at H/(Pu + U) = 7.3.

R. C. Lloyd and E. D. Clayton, "Criticality of Plutonium-Uranium Nitrate Solutions," Nucl. Sci. Eng. **60**, 143-146 (June 1976).

61-cm-diam cylinder, ~30 wt% Pu in Pu + U(0.66), 12 to 97 g Pu/liter, water reflector; 35.7-, 38.6-cm-diam spheres, ~30, ~15 wt% Pu, 35 to 71 g Pu/liter, water reflector; effect of Gd.

S. R. Bierman, "Critical Experiments—Benchmarks (Pu + U Systems)," Nucl. Technol. **26**, 352-381 (July 1975).

Reevaluation of Hanford and AWRE critical specifications; ~30, ~15, ~8 wt% Pu solutions and hydrogenous solids, 42 to 4800 g (Pu + U)/liter, mostly hydrogenous reflector.

S. R. Bierman and E. D. Clayton, "Critical Experiments to Measure the Neutron Poisoning Effects of Copper and Copper-Cadmium Plates," Nucl. Sci. Eng. **55**, 58-66 (September 1974).

PuO_2-UO_2-polystyrene, ~15, ~30 wt% Pu in Pu + U, H/(Pu + U) = 2.8, 30.6, Plexiglas reflector, 1/8- to 1-in. Cu or Al, 1/8- or 3/4-in. Cu-Cd (1 wt%).

R. C. Lloyd, S. R. Bierman, and E. D. Clayton, "Criticality of Plutonium-Uranium Mixtures Containing 5 to 8 wt% Plutonium," Nucl. Sci. Eng. **55**, 51-57 (September 1974).

61-cm-diam cylinder, Pu + U(0.66) solution at ~5 to 7 wt% Pu in Pu + U, H/(Pu + U) ~60 to 80, partial water reflector; PuO_2-UO_2-polystyrene parallelepiped, 7.6% Pu, H/(Pu + U) = 19.5, Plexiglas reflector.

R. C. Lane and C. Parker, "Measurement of the Critical Size of Solutions of Plutonium and Natural Uranium Nitrates at Pu/U = 0.3," United Kingdom Atomic Energy Authority report AWRE 0 58/73 (December 1973).

254-, 306-, 380-, 507-mm-diam cylinders at 330, 32, 18.6, 17.5 g Pu/liter, water reflector.

S. R. Bierman, E. D. Clayton, and L. E. Hansen, "Critical Experiments with Homogeneous Mixtures of Plutonium and Uranium Oxides Containing 8, 15, and 30 wt% Plutonium," Nucl. Sci. Eng. **50**, 115-126 (February 1973).

PuO_2-U(0.15)O_2-polystyrene parallelepipeds, H/(Pu + U) = 31, 47, 52, polyethylene reflector (some bare), shape variation including slabs.

O. J. E. Perkins, "The Measurement of the Critical Size of a Homogeneous Mixture of Pu and Natural Uranium Oxides with Polyethylene," United Kingdom Atomic Energy Authority report AWRE 0 32/68 (July 1968).

Homogeneous mixture, H/Pu = 18.6, Pu/U = 0.335, near cube in 20-cm-thick polyethylene.

M. Gibson and R. G. Harper, "Comparison of Lattice Physics Experiments in Heated Graphite Stacks Containing Plutonium-Uranium Fuel with Theoretical Prediction," J. Nucl. Energy **19**, 343-356 (May 1965).

SCORPIO heated assemblies, 1.2-in.-diam Pu-U rods at 0.25 wt% Pu in Pu + U, latticed in graphite, buckling to ~0.3%.

F. Metallic Pu with U(93)

G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory report LA-4208 (September 1969).

Benchmark assemblies: bare spheres of U(94), δ-Pu, ^{233}U, Pu-U(93), ^{233}U-U(93); U(93), δ-Pu, ^{233}U spheres in thick U(nat); α-Pu sphere in water; bare cylinders of Av. U(53.3), U(37.5), U(16.0), U(14.1), U(12.3), U(10.9); Av. U(16.2) cylinder in 3-in-thick U(nat) (see II.A.7, II.B.2, II.D.4, and II.G).

D. M. Barton, W. Bernard, and G. E. Hansen, "Critical masses of Composites of Oy and Pu-239-240 in Flattop Geometry," Los Alamos Scientific Laboratory report LAMS-2489 (April 12, 1961).

2.15-in.-diam α-Pu spheres, 2.3, 4.7, 16.1% ^{240}Pu, in U(93) shell, 19-in.-o.d. U(nat) reflector.

E. A. Plassmann and D. P. Wood, "Critical Reflector Thickness for Spherical U^{233} and Pu^{239} Systems," Nucl. Sci. Eng. 8, 615-620 (December 1960).

8.39-kg Pu and 7.60- or 10.01-kg ^{233}U in U(93), Be, W alloy, U(nat) (see II.D.4 and II.G).

G. ^{233}U

G. E. Hansen and H. C. Paxton, "Reevaluated Critical Specifications of Some Los Alamos Fast-Neutron Systems," Los Alamos Scientific Laboratory report LA-4208 (September 1969).

Benchmark assemblies: bare spheres of U(94), δ-Pu, ^{233}U, Pu-U(93), ^{233}U-U(93); U(93), δ-Pu, ^{233}U spheres in thick U(nat); α-Pu sphere in water; bare cylinders of Av. U(53.3), U(37.5), U(16.0), U(14.1) U(12.3), U(10.9); Av. U(16.2) cylinder in 3-in.-thick U(nat) (see II.A.7, II.B.2, II.D.4, and II.F).

J. G. Bruna, J. P. Brunet, R. Caizergues, C. Clouet d'Orval, and P. Verriere, "Results of Homogeneous Critical Experiments Carried Out with ^{239}Pu, ^{235}U and ^{233}U," (in French) *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 235-248.

ALECTO at Saclay: 25- to 42-cm-diam cylinders, ^{239}Pu-, ^{235}U-, ^{233}U-nitrate solutions, 15 to 18 g Pu/liter, 30 to 300 g ^{235}U/liter, 25 to 250 g ^{233}U/liter, bare, water reflector (see II.A.1 and II.D.1).

L. A. Mountford and H. A. Morewitz, "The Advanced Epithermal Thorium Reactor (AETR) Critical Experiments," Nucl. Sci. Eng. **21**, 421-428 (April 1965).

5-region pseudospheres: ^{233}U or ^{235}U, Th, C, Al, Fe test region; similar ^{235}U buffer; Th decoupler; ^{235}U, polyethylene driver; polyethylene reflector.

E. A. Plassmann and D. P. Wood, "Critical Reflector Thickness for Spherical U^{233} and Pu^{239} Systems," Nucl. Sci. Eng. **8**, 615-620 (December 1960).

8.39-kg Pu and 7.60- or 10.01-kg ^{233}U in U(93), Be, W alloy, U(nat) (see II.D.4 and II.F).

J. K. Fox, L. W. Gilley, and E. R. Rohrer, "Critical Mass Studies, Part VIII. Aqueous Solutions of U^{233}," Oak Ridge National Laboratory report ORNL-2143 (September 23, 1959).

$UO_2(NO_3)_2$ and UO_2F_2 solutions, H/^{233}U = 34 to 775; 10.4-in.-diam sphere in water, 12.6-in.-diam sphere bare and in water; 12.7- to 30.5-in.-diam cylinders bare and in water or paraffin.

W. G. Clarke, C. C. Horton, and M. F. Smith, "Critical Assemblies of Aqueous Uranyl Fluoride Solutions, Part I, Experimental Techniques," United Kingdom Atomic Energy Authority report AERE R/R 2051 (September 20, 1956).

U(44.6) or ^{233}U as UO_2F_2 solutions, 12-in.-diam cylinder, bare and thick lateral water reflector, H/(^{235}U or ^{233}U) = 250 to 850 (see II.B.1).

J. T. Thomas, J. K. Fox, and D. Callihan, "A Direct Comparison of Some Nuclear Properties of U-233 and U-235," Nucl. Sci. Eng. **1**, 20-32 (March 1956).

^{233}U and ^{235}U as uranyl fluoride solutions, H/^{233}U ~380 and 600, H/^{235}U ~240 and 460, 26.4- and 32.0-cm-diam spheres in water (see II.A.1).

III. MODERATED LATTICES

A. Hydrogenous

1. Enriched U

E. B. Johnson, "The Criticality of Heterogeneous Lattices of Experimental Beryllium Oxide Reactor Fuel Pins in Water and in Aqueous Solutions Containing Boron and Uranyl Nitrate," Oak Ridge National Laboratory report ORNL/ENG-2 (July 1976).

Lattices of $U(62.4)O_2$-BeO fuel pins in water, and in uranyl nitrate solution at 3.7 g ^{235}U/liter with and without 0.3 g B/liter (also arrays of elements consisting of 18 pins in square BeO).

R. L. Currie, P. B. Parks, and J. L. Jarriel, "Static and Pulsed Reactivity Measurements on Large Uranium-235 Fuel Forms in Water," Nucl. Technol. **12**, 356-362 (December 1971).

9.9 wt% U(92.2)-Al, lattices of 11.2-cm i.d. by 20.1-cm o.d. by 113-cm long, and 10.1-cm i.d. by 12.3-cm o.d. by 112-cm-long clad with 0.15-cm Al; various pitches to k_{eff} = 0.98 and 0.95, respectively.

V. O. Uotinen, J. H. Lauby, W. P. Stinson, and S. R. Dwivedi, "Reactor Kinetic Parameters of Lattices of Plutonium and Uranium in Water," Nucl. Sci. Eng. **44**, 66-71 (April 1971).

Fuel rods: Al-Pu, $U(2.3)O_2$, $U(0.16)O_2$-1.5 wt% PuO_2, and $U(nat)O_2$-2 wt% PuO_2 (7.6, 23.5% ^{240}Pu) (see III.A.3).

C. L. Brown and R. C. Lloyd, "Material Bucklings for 1.002, 1.25, and 1.95 wt% Uranium-235-Enriched Uranium Tubes in Light Water," Nucl. Sci. Eng. **27**, 10-15 (January 1967).

Lattices of various single and double tubes carried to 96% of critical mass.

E. C. Crume and E. B. Johnson, "Criticality Safety Tests for Rover Reactor Fuel Elements," Oak Ridge National Laboratory report ORNL-TM-1704 (December 1, 1966).

$U(93.15)C_2$-graphite elements, 0.42 g U/cm^3, water-moderated and reflected lattices, some with B_4C.

E. B. Johnson and R. K. Reedy, "Critical Experiments with SPERT-D Fuel Elements," Oak Ridge National Laboratory report ORNL-TM-1207 (July 14, 1965).

22 Al-clad 0.020-in.-thick U(93.17)-Al (23.8 wt% U) plates, 0.047-in. spacing, in $U(92.6)O_2(NO_3)_2$ solution at 4.0 g ^{235}U/liter, also with 0.39 to 1.12 g B/liter.

C. R. Richey, R. C. Lloyd, and E. D. Clayton, "Criticality of Slightly Enriched Uranium in Water-Moderated Lattices," Nucl. Sci. Eng. 21, 217-226 (February 1965).

U(1.01, 2.00, 3.06) rods, 0.175- to 1.66-in. diam.

W. B. Rogers, Jr., and F. E. Kinard, "Material Buckling and Critical Masses of Uranium Rods Containing 3 wt% U^{235} in H_2O," Nucl. Sci. Eng. **20**, 266-271 (November 1964).

2- and 3-in.-diam rods, spacings span maximum buckling (Hanford data on 0.175- to 0.925-in.-diam rods included).

J. Coehoorn, J. G. Ackers, M. Bustraan, A. Tas, W. L. Zijp, M. Nuysken, W. W. Nijs, R. J. Heyboer, and F. Luidinga, "The Critical Facility Krito," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. II, pp. 233-256.

Latticed 1.0-cm-diam $U(3.1)O_2$ rods, H_2O/UO_2 Vol. ratio = 1.34, clean critical.

E. B. Johnson and J. K. Fox, "Critical Mass Studies, Part XII: Rover Reactor Fuel Elements," Oak Ridge National Laboratory report ORNL-TM-264 (September 18, 1962).

$U(93.15)C_2$-graphite elements, C/^{235}U = 90, water-moderated and reflected lattices, spacings span minimum critical mass.

J. K. Fox and L. W. Gilley, "Critical Mass Studies: Part XI, Critical Parameters of Uranium-Aluminum Alloy Slugs," Oak Ridge National Laboratory report ORNL-3272 (May 28, 1962).

1.015-in.-diam rods containing 5.4 wt% U(93), water-moderated and reflected.

T. C. Engelder, N. L. Snidow, R. H. Clark, C. E. Barksdale, R. H. Lewis, and M. N. Baldwin, "Spectral Shift Control Reactor Basic Physics Program, Critical Experiments on Lattices Moderated by D_2O-H_2O Mixtures," The Babcock and Wilcox Company report BAW-1231 (December 1961).

0.44-in.-diam by 66.7-in.-long $U(4)O_2$ in ss, 480 to 5200 latticed in water containing 0 to 76 mol% D_2O, some with B in solution; 0.26-in.-diam by 62-in.-long $U(93)O_2$-ThO_2 (Th/^{235}U = 15) in Al, ~2200 latticed in water containing 60 mol% D_2O; 14- to 50-cm-thick moderator as radial reflector (see III.B).

R. C. Lloyd, "Summary Listing of Subcritical Measurements of Heterogeneous Water-Uranium Lattices Made at Hanford," Hanford Atomic Products Operation report HW-65552 (June 8, 1960).

U(nat), U(0.95), U(1.007), U(1.25), U(~1.44), U(1.6), U(3.06) rods, hollow cylinders [B solutions with 0.925-in.-diam U(1.007) rods] (see III.A.2).

W. H. Arnold, Jr., "Critical Masses and Lattice Parameters of H_2O-UO_2 Critical Experiments: A Comparison of Theory and Experiment," Yankee Atomic Electric Company report YAEC-152 (November 1959).

$U(1.3, 2.7, 4.0, 4.4)O_2$, 0.76-, 0.98-, 1.13-, 1.52-cm-diam rods latticed at water/uranium Vol. ratios = 2.2 to 5, some with B solution (a summary of extant data).

P. W. Davison, V. E. Grob, D. F. Hanlen, R. D. Leamer, H. Ritz, and E. Santandrea, "Two-Region Critical Experiments with Water-Moderated Slightly Enriched UO_2 Lattices," Yankee Atomic Electric Company report YAEC-142 (November 30, 1959).

48-in.-long by 0.30-in.-diam $U(2.7)O_2$, 1300 or 1800 latticed; 55-in.-long by 0.30-in.-diam $U(4.4)O_2$, 750 or 1040 latticed; 795 $U(2.7)O_2$ rods surrounded by 830 or 1300 $U(4.4)O_2$ rods; 997 $U(2.7)O_2$ rods surrounded by 780 or 1188 $U(4.4)O_2$ rods; thick water reflector.

P. W. Davison, S. S. Berg, W. H. Bergmann, D. F. Hanlen, B. Jennings, R. D. Leamer, and J. E. Howard, "Yankee Critical Experiments—Measurements on Lattices of Stainless Steel Clad Slightly Enriched Uranium Dioxide Fuel Rods in Light Water," Yankee Atomic Electric Company report YAEC-94 (April 1, 1959).

0.3-in.-diam $U(2.7)O_2$ rods at water/uranium Vol. ratio = 2.2, 2.9, 3.9.

J. K. Fox and L. W. Gilley, "Critical Experiments with Arrays of ORR and BSR Fuel Elements," Oak Ridge National Laboratory report ORNL-CF-58-9-40 (October 2, 1958).

Elements of U(93.15)-Al plates, 140, 168, 200 g ^{235}U each, various flooded lattices, Cd effect.

J. K. Fox, J. T. Mihalczo, and L. W. Gilley, "Critical Experiments with 2.09% U^{235} Enriched Uranium Metal Plates in Water," Oak Ridge National Laboratory report ORNL-CF-58-8-3 (August 3, 1958).

30-in.-long by 3.125-in.-wide by 0.25-in.-thick plates, sets of four spaced 0.625 to 1.125 in.

W. W. Brown, "Exponential Experiments with Organic Moderated Uranium Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 514-517.

1-in.-diam U(0.721) and U(0.912) rods in diphenyl (see III.A.2).

H. Kouts, R. Sher, J. R. Brown, D. Klein, S. Stein, R. L. Hellens, H. Arnold, R. M. Ball, and P. W. Davison, "Physics of Slightly Enriched, Normal Water Lattices (Theory and Experiment)," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 446-482.

BNL: 0.250- or 0.387-in.-diam U(1.027), U(1.143), U(1.299) rods, exponentials; Bettis: 0.38-, 0.60-in-diam U(1.3), $U(1.3)O_2$ rods, 0.60-in.-diam U(1.15) rods, criticals; WAPD: 0.300-in.-diam $U(2.7)O_2$, criticals.

H. Kouts and R. Sher, "Experimental Studies of Slightly Enriched Uranium, Water Moderated Lattices, Part I. 0.600-in.-Diameter Rods," Brookhaven National Laboratory report BNL 486 (September 1957).

U(1.0), U(1.15), U(1.3) rods, buckling, reflector savings, physics parameters.

J. C. Hoogterp, "Critical Masses of Oralloy Lattices Immersed in Water," Los Alamos Scientific Laboratory report LA-2026 (March 6, 1957).

0.5-, 1.0-in. cubes, 1/8-in.-diam rods of U(94) at various spacings; single water-reflected cube (see II.A.7).

D. V. P. Williams, D. W. Magnuson, M. L. Batch, W. R. Johnson, J. K. Leslie, and D. Callihan, "Army Package Power Reactor Critical Experiment" Oak Ridge National Laboratory report ORNL-2128 (August 21, 1956).

0.002-in.-thick U(93.2) in 0.011-in.-thick ss, latticed in water, 9.5 to 19.7 vol% metal.

E. D. Clayton (and H. Neumann), "Exponential Pile Measurements in Water Moderated Lattices with Enriched Uranium Rods (Buckling Calculations for One Per Cent Enriched Uranium-Water Rod Lattices)," Hanford Atomic Products Operation report HW-40930 (January 16, 1956).

0.925-, 1.66-in.-diam U(1.007) rods at H_2O/U Vol. ratio = 0.86 to 2.15.

S. Krasik and A. Radkowsky, "Pressurized Water Reactor (PWR) Critical Experiments," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 203-214.

0.600-in.-diam U(1.15, 1.3), 0.387-in.-diam U(1.3) rods, critical lattices.

H. Kouts, G. Price, K. Downes, R. Sher, and V. Walsh, "Exponential Experiments in Light Water," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 183-202.

ORNL: U(nat) rods, $B^2 > 0$ when latticed with air annulus about each rod; BNL: latticed 0.75-in.-diam U(1.027) rods (see III.A.2).

J. W. Noaks and J. S. Crudele, "Preliminary Critical Assembly for Super Critical Water Reactor, Part II," Oak Ridge National Laboratory report ORNL CF-54-12-21 (December 1, 1954).

$U(93)O_2F_2$ solution, 0.5 kg ^{235}U/liter, in 1-in.-diam ss tubes, latticed, flat-flux distribution, furfural moderator and reflector to simulate high-temperature water.

D. Callihan, D. F. Cronin, J. K. Fox, J. W. Morfitt, E. R. Rohrer, and D. V. P. Williams, "Critical Mass Studies, Part VI," Oak Ridge Y-12 Plant report Y-801 (August 8, 1951).

Supplements K-644 (July 11, 1950) on 1.35-in.-diam by 8-in. U(93.3)-Al P-10 slugs, 41.5 g U each, latticed in water.

D. Callihan, J. D. McLendon, and J. W. Morfitt, "Criticality Test on P-10 Alloy Slugs," Oak Ridge Gaseous Diffusion Plant report K-644 (July 11, 1950).

1.35-in.-diam (with boss) by 9-in. U(93.2)-92.5% Al rods, each 47.7 g ^{235}U, face-centered lattice in water.

A. B. Martin and M. M. Mann, "Further Critical Experiments on a Small Reactor of Enriched U-235 with Al-H_2O Moderator and Beryllium Reflector," Oak Ridge National Laboratory report ORNL-79 (August 17, 1948).

Fuel as of Mon P-357 (August 18, 1947), Al/H_2O Vol. ratio 0.65, near-equilateral and slab.

M. M. Mann and A. B. Martin, "Critical Experiments on a Small Reactor of Enriched U^{235} with Al-H_2O Moderator and D_2O, Be, and H_2O Reflectors," Clinton Laboratories report Mon P-357 (August 18, 1947).

UO_2F_2 solution, 35.6 g ^{235}U/liter, in 1- by 1-in.-square Al tubes, Al/H_2O Vol. ratio = 0.66 to 0.88, tubes close packed, $\geq$ 50-cm-thick D_2O, ~25-cm Be, thick H_2O reflectors.

2. U(nat)

I. H. Gibson and J. Walker, "Pulsed Source Measurements on a Uranium-Water Subcritical Assembly," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. I, pp. 469-479.

1.2-in.-diam U(nat) rods at 1.55-, 1.71-, 1.90-, 2.0-in. pitch, $k_\infty < 1$.

W. K. Mansfield and J. M. Kim, "Exponential Experiments with Water and Natural Uranium Lattices," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. I, pp. 457-467.

1.2-in.-diam rods at 1.8-, 2.0-, 2.2-in. pitch, $B^2 < 0$.

R. C. Lloyd, Summary Listing of Subcritical Measurements of Heterogeneous Water-Uranium Lattices Made at Hanford," Hanford Atomic Products Operation report HW-65552 (June 8, 1960).

U(nat), U(0.95), U(1.007), U(1.25), U(~1.44), U(1.6), U(3.06) rods, hollow cylinders [B solutions with 0.925-in.-diam U(1.007) rods] (see III.A.1).

W. W. Brown, "Exponential Experiments with Organic Moderated Uranium Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 514-517.

1-in.-diam U(0.721) and U(0.912) rods in diphenyl (see III.A.1).

H. Kouts, G. Price, K. Downes, R. Sher, and V. Walsh, "Exponential Experiments in Light Water," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 183-202.

ORNL: U(nat) rods, $B^2 > 0$ when latticed with air annulus about each rod; BNL: latticed 0.75-in.-diam U(1.027) rods (see III.A.1).

H. Kouts, G. Price, K. Downes, R. Sher, and V. Walsh, "Reactor Parameters of a Light Water-Normal Uranium Lattice," (Letter) J. Nucl. Energy **2**, 141 (November 1955).

1.1-in.-diam rod lattice, $B^2 < 0$ but more positive than ORNL value.

K. Downes, "Buckling of a Natural Uranium Light Water Moderated Lattice," Brookhaven National Laboratory report BNL-2016 (August 23, 1954).

1.1-in.-diam rods at water/U Vol. ratio = 1.5, $k_\infty = 0.99$; ORNL and Swedish (R. Persson) results included.

G. Branch, H. Jones, J. H. Rush, and A. M. Weinberg, "Water Lattice Experiments," Clinton Laboratories report CP-2842 (October 26, 1945).

1.0-, 1.4-in.-diam U(nat) rods, H_2O/U Vol. ratio = 1.56 to 2.10, $k_\infty = 1.003$ for 1.4-in.-diam with air annulus about each rod and $H_2O/U = 1.56$.

3. Pu

R. C. Lloyd and E. D. Clayton, "Criticality Safety Data Applicable to Processing Liquid Metal Fast Breeder Reactor Fuel," Nucl. Sci. Eng. **59**, 21-26 (January 1976).

0.5-in.-diam PuO_2-U(nat)O_2 rods, 25 wt% Pu, latticed in Pu + U solution at 1 to 255 g (Pu + U)/liter, effect of Gd, directed toward dissolver.

V. O. Uotinen, J. H. Lauby, L. C. Schmid, and W. P. Stinson, "Lattices of Plutonium-Enriched Rods in Light Water—Part I: Experimental Results," Nucl. Technol. **15**, 257-271 (August 1972).

U(nat)O_2-PuO_2 rods from 1.5 to 4.0 wt% PuO_2, Al-Pu rods from 1.8 to 5.0 wt% Pu, extrapolations from ~50 to 96% critical size.

V. O. Uotinen, J. H. Lauby, W. P. Stinson, and S. R. Dwivedi, "Reactor Kinetic Parameters of Lattices of Plutonium and Uranium in Water," Nucl. Sci. Eng. **44**, 66-71 (April 1971).

Fuel rods: Al-Pu, U(2.3)O_2, U(0.16)O_2-1.5 wt% PuO_2, and U(nat)O_2-2 wt% PuO_2 (7.6, 23.5% ^{240}Pu) (see III.A.1).

G. A. Price and H. H. Windsor, "Pu-Al-H_2O Buckling Measurements," Brookhaven National Laboratory report BNL-RP-8(F) (October 1, 1969).

0.6-in.-diam 10 wt% Pu rods latticed in water, minimum critical number at H_2O/(Pu + Al) Vol. ratio ~5.5.

V. I. Neeley, R. C. Lloyd, and E. D. Clayton, "Neutron Multiplication Measurement with Pu-Al Rods in Light Water," Hanford Atomic Products Operation report HW-70944 (August 29, 1961).

0.5-in.-diam Zircaloy-clad Pu(5 wt%)-Al rods, latticed, to 96% of critical number.

4. ^{233}U

H. H. Windsor, W. J. Tunney, and G. A. Price, "Exponential Experiments with Lattices of Uranium-233 Oxide and Thorium Oxide in Light and Heavy Water," Nucl. Sci. Eng. **42**, 150-161 (November 1970).

3% $^{233}UO_2$-97% ThO_2 rods in H_2O with 0 to 25 g H_3BO_3/liter, spans $B^2 = 0$ (D_2O lattices unpoisoned) (see III.B).

B. D_2O

H. H. Windsor, W. J. Tunney, and G. A. Price, "Exponential Experiments with Lattices of Uranium-233 Oxide and Thorium Oxide in Light and Heavy Water," Nucl. Sci. Eng. **42**, 150-161 (November 1970).

3% $^{233}UO_2$-97% ThO_2 rods in H_2O with 0 to 25 g H_3BO_3/liter, spans $B^2 = 0$ (D_2O lattices unpoisoned) (see III.A.4).

I. Kaplan, D. D. Lanning, A. E. Profio, and T. J. Thompson, "Massachusetts Institute of Technology Exponential Assembly Studies of Low-Enrichment, Heavy-Water Lattices," *Exponential and Critical Experiments*, Proc. Amsterdam Conf. (IAEA, Vienna, 1964) Vol. II, pp. 109-146.

1.0-in.-diam U(nat), 4.5-, 5.0-, 5.5-in. pitch, summary of extant B^2 data.

W. E. Graves, H. R. Fike, and G. F. O'Neill, "Experimental Buckling and Void Effects in Heavy Water Lattices of Natural Uranium Oxide Rod Clusters," Nucl. Sci. Eng. **16**, 186-195 (June 1963).

One lattice of 0.5-in.-diam rods fills ~16-ft-diam tank uniformly (also clusters).

E. C. Wingfield and E. J. Hennelly, "Exponential Measurements of Natural Uranium Rods in Heavy Water and Comparisons with Critical Experiments," Nucl. Sci. Eng. **12**, 348-358 (March 1962).

1-in.-diam U(nat) rods, single-rod lattices range through minimum B^2 (also clusters).

T. J. Hurley, H. R. Fike, and G. F. O'Neill, "Experimental Bucklings of Heavy Water Moderated Lattices of Natural Uranium Metal Rod Clusters," Nucl. Sci. Eng. **12**, 341-347 (March 1962).

1-in.-diam rods, four single-rod lattices (also clusters).

T. C. Engelder, N. L. Snidow, R. H. Clark, C. E. Barksdale, R. H. Lewis, and M. N. Baldwin, "Spectral Shift Control Reactor Basic Physics Program, Critical Experiments on Lattices Moderated by D_2O-H_2O Mixtures," The Babcock and Wilcox Company report BAW-1231 (December 1961).

0.44-in.-diam by 66.7-in.-long $U(4)O_2$ in ss, 480 to 5200 latticed in water containing 0 to 76 mol% D_2O, some with B in solution; 0.26-in.-diam by 62-in.-long $U(93)O_2$-ThO_2 (Th/^{235}U = 15) in Al, ~2200 latticed in water containing 60 mol% D_2O; 14- to 50-cm-thick moderator as radial reflector (see III.A.1).

W. C. Redman and J. A. Thie, "Properties of Exponential and Critical Systems of Thoria-Urania and Heavy Water and Their Application to Reactor Design," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 402-413.

0.23-in.-diam ThO_2-U(~93)O_2 rods latticed, Th/^{235}U = 25, 50, exponentials, critical with Th/^{235}U = 25; some fuel clusters.

D. Popović, "A Bare Critical Assembly of Natural Uranium and Heavy Water," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 392-394.

2.5-cm-diam rods on 12-cm pitch, 200-cm-diam by 210-cm-high bare core.

R. Persson, E. Blomsjö, E. Anderson, O. Aspelund, and J. Döderlein, "Exponential Experiments on Heavy Water Natural Uranium Metal and Oxide Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 364-373.

Extension of Proc. 1st UN Geneva Conf. **5**, 239-241 with 3.05-cm-diam rods, also clusters of 1.25-cm-diam metal rods and 1.22- and 1.56-cm-diam oxide rods.

D. W. Hone, E. Critoph, M. F. Duret, R. E. Green, A. Okazaki, R. M. Pearce, and L. Pease, "Natural-uranium Heavy-water Lattices, Experiment and Theory," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 351-363.

Exponentials with 3.26-, 3.80-cm-diam rods (also tubes) each in 0.25- to 0.30-cm annulus containing H_2O or air; some clustered rods.

E. R. Cohen, "Exponential Experiments on D_2O-Uranium Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 268-278.

1-in.-diam U(0.496, 0.720, 0.912) rods; 2-in.-diam U(0.496, 0.720) rods; 0.75-, 1.25-, 1.50-in.-diam U(0.720) rods; ANL results with 1.00-in.-diam U(nat) rods; all in 5-ft-diam tanks.

R. Persson, M. Bustraan, and E. Blomsjö, "Some Experiences on an Exponential Pile of Uranium and Heavy Water," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 239-241.

2.57-, 3.05-cm-diam U(nat) rods latticed in 1-m-diam tank.

A. H. Snell, "Criticality Studies on Enriched Uranium-Heavy Water Systems," Clinton Laboratories report Mon P-454 (January 16, 1947).

2.5-in.-diam tubes of ^{235}U-D_2O solution latticed in tank of D_2O at average of 2.58, 10.35 g ^{235}U/liter, ~30-, 50-cm-thick D_2O reflector.

C. Be or BeO

D. B. McCulloch, P. Duerden, and E. Brittliff, "Buckling and Integral Spectrum Measurements in U^{235} Fueled Sub-Critical Assemblies Moderated by BeO/Fertile Material Mixtures," Australian Atomic Energy Commission report AAEC/E146 (December 1965).

0.040-in.-thick 23.4 wt% U(89.4)-Al in BeO containing 4.3 wt% U(nat) or Th, Be/^{235}U = 1540 to 6500.

P. Duerden, D. B. McCulloch, and E. Brittliff, "Buckling and Integral Spectrum Measurements in U^{235} BeO Sub-Critical Assemblies," Australian Atomic Energy Commission report AAEC/E123 (July 1964).

0.040-in.-thick 23.4 wt% U(89.4)-Al in BeO at Be/^{235}U = 1460, 2930, 5860, 8790.

P. Benoist, V. Deniz, Ch. Gourdon, B. V. Joshi, J. Martelly, M. Sagot, K. Sahai, and G. Wanner, "Critical and Subcritical Experiments with U-BeO Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 585-606.

2.60-, 2.92-, 3.56-cm-diam U(nat) rods in BeO for exponentials, some U(1.35) for critical.

A. K. Krasin, B. G. Dubovsky, M. N. Lantsov, Y. Y. Glazkov, R. K. Goncharov, A. Y. Kamayev, L. A. Geraseva, V. V. Vavilov, E. I. Inyutin, and A. P. Senchenkov, "Physical Characteristics of Beryllium Moderated Reactor," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 571-579.

$U(10)_3O_8$ powder in 0.9- or 1.34-cm-diam tubes latticed in Be, Be/^{235}U = 1777 to 3112, 0- to 15-cm lateral Be-H_2O reflector; also with H_2O in core.

H. B. Stewart, P. L. Hofmann, and M. L. Storm, "Physics Considerations in the Design of Intermediate Energy Spectrum Reactors," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 142-150.

63-liter core at Be/^{235}U = 1.7 in thick Be; 85-liter core at Be/^{235}U = 33 in thick Be; 272-liter core at Be/^{235}U = 1.78 in thick Be + void.

A. K. Krasnin and B. G. Dubovsky, "A Beryllium-Moderated Reactor," (Letter) J. Nucl. Energy 4, 520-521 (April 1957).

$U(10)_3O_8$ in ~ 0.13-cm-thick steel-wall annuli latticed in Be, bare, and 15.5-cm lateral Be reflector; effect of water.

T. M. Snyder, "The Critical Assembly—A Nuclear Design Tool," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 162-171.

0.020-in. ^{235}U interleaved with 0.1-, 0.4-, 0.8-in.-thick Be, 85-liter core at Be/^{235}U = 45.4, 32.6 (with Fe, Na, Al), reflector of 100-liter Be (with Fe, Al) in 12-in.-thick U(nat).

D. Graphite

D. E. Wood, "Material Buckling Measurements on Graphite-Uranium Systems at Hanford: A Summary Tabulation," Hanford Atomic Products Operation report HW-69525 (May 1961).

0.925- to 2.5-in.-diam U(nat) rods spaced in graphite from 4.4 to 15 in.; 1.336-in.-diam U(0.94); 0.925-, 1.66-in.-diam U(1.007); 1.343-in.-diam U(93)-Al; also clustered rods, tubes, rods in tubes.

P. Bacher, J.-C. Koechlin, R. de Mazancourt, A. Teste du Bailler, and C.-P. Zaleski, "Natural Uranium-Graphite Lattices," Proc. Intern. Conf. Peaceful Uses At. Energy, 2nd, Geneva, 1958 (United Nations, New York, 1958) Vol. 12, pp. 666-684.

2.6- to 3.2-cm-diam U(nat) rods, C/U = 57 to 117.

D. E. Davenport, "Exponential Experiments in Graphite Systems," Proc. Intern. Conf. Peaceful Uses At. Energy, 1st, Geneva, 1955 (United Nations, New York, 1956) Vol. 5, pp. 309-316.

Hanford: 0.925-, 1.175-, 1.36-, 1.66-in.-diam U(nat) rods latticed at C/U = 32 to 199; NAA: 1-in.-diam rods of U(nat), U(0.49), U(0.90).

IV. INTERACTING UNITS

A. Enriched U

1. Solutions, Mixtures

D. W. Magnuson, "Critical Experiments with Enriched Uranium Dioxide," Oak Ridge Y-12 Plant report Y-DR-120 (November 30, 1973).

0.4-, 20-kg $U(93)O_2$ dry cylinders, 17-kg with alcohol, one- and two-high arrays with polyethylene reflector; maximum reactivity with ~4-cm Plexiglas between units.

J. Bouly, R. Caizergues, E. Deilgat, M. Houelle, and L. Maubert, "Neutron Interaction in Air of Cylindrical Containers Holding either Uranium or Plutonium Solutions," (in French) French Commissariat of Atomic Energy report CEA-R-3946 (March 1970).

Two, three, or four 300-, 256-mm-diam Pu-solution cylinders, 115, 152 g Pu/liter; two 300-mm-diam ^{235}U-solution cylinders at 81, 90, 110 g ^{235}U/liter; also dissimilar cylinders (see IV.B).

J. T. Thomas, "Experimental and Calculated System Criticality," *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 149-175.

Recapitulation of data on Oak Ridge arrays: two and three U(93.2) disks on same axis; 5.2-, 10.5-, 15.7-, 20.9-, 26.2-kg U(93.2) metal cylinders, n^3 arrays (n = 2, 3, 4); 5-liter $U(92.6)O_2(NO_3)_2$ solution cylinders at $H/^{235}U$ = 59, 92, 440, planar and n^3 arrays (n = 2, 3, 4, 5); 24-cm-diam by 152-cm-high $U(4.9)O_2F_2$ solution cylinders, planar arrays of 5 to 27 units (see IV.A.2).

B. G. Dubovskii, A. V. Kamaev, G. M. Vladykov, F. N. Kuznetsov, V. Z. Nozik, Yu. D. Palamarchuk, G. A. Popov, and V. V. Vavilov, "Interaction of Subcritical Reactors," J. Nucl. Energy **19**, 271-277 (April 1965).

Two, three, or four 30-cm-diam $U(90)O_2(NO_3)_2$ solution cylinders, or 30-cm-square parallelepipeds, at 71 g U/liter; larger arrays (to 67 units) of 18-cm-diam by 24-cm-high cylinders at 6(?) g U/liter; no reflector.

J. T. Thomas, "Critical Three-Dimensional Arrays of Neutron-Interacting Units," Oak Ridge National Laboratory report ORNL-TM-719 (October 1, 1963).

5-liter $U(93)O_2(NO_3)_2$ cylinders at 415 g U/liter, arrays up to 125 units bare, 1-in. Plexiglas, 0.5-, to 12-in. paraffin reflectors.

A. V. Kamaev, B. G. Dubovskii, V. V. Vavilov, G. A. Popov, Yu. D. Palamarchuk, and S. P. Ivanov, "Experimental Investigation of Effects of Interaction of Two Subcritical Reactors," U.S. Atomic Energy Commission translation AEC-tr-4708 (October 9, 1962).

30-cm-diam $U(90)O_2(NO_3)_2$ solution cylinders at $H/^{235}U$ = 260 to 520, bare, graphite reflector.

J. K. Fox, L. W. Gilley, and D. Callihan, "Critical Mass Studies, Part IX, Aqueous U^{235} Solutions," Oak Ridge National Laboratory report ORNL-2367 (March 4, 1958).

$U(93.2)O_2F_2$ solution, $H/^{235}U$ = 27 to 75; interaction of three and seven 6- and 8-in.-diam cylinders in air and water; individual 6- to 30-in.-diam cylinders and 9-in.-diam sphere, bare, water reflected; 8- to 20-in.-o.d. annuli; also "Y" and "cross," and comparison of furfural, concrete, graphite, firebrick reflectors with water (see II.A.I).

J. K. Fox and L. W. Gilley, "Preliminary Report of Critical Experiments in Slab Geometry," Oak Ridge National Laboratory report ORNL-CF-56-7-148 (July 30, 1956).

$U(\sim90)O_2F_2$ solution at $H/^{235}U$ = 337, interaction of two 3-, 6-in.-thick slabs, three 3-in.-thick slabs, in air or water (slabs 4-ft wide).

J. D. McLendon and J. W. Morfitt, "Critical Mass Tests on Oralloy Machine Turnings," Oak Ridge Y-12 Plant report Y-A2-71 (February 29, 1952).

U(93.4) as ~0.005-in.-thick turnings in water, $H/^{235}U$ = 60, 80, 120, one to six 8- or 10-in.-diam cylinders in water; critical mass ~18% above that of corresponding solution (see II.A.3).

D. Callihan, D. F. Cronin, J. K. Fox, R. L. Macklin, and J. W. Morfitt, "Critical Mass Studies, Part IV," Oak Ridge Gaseous Diffusion Plant report K-406 (November 28, 1949).

Two 5-, 5.5-, 6-, 8-, 10-, 15-, 20-in.-diam $U(93)O_2F_2$ solution cylinders, $H/^{235}U$ = 30, 53, 169, 329, bare and flooded.

2. Metal

J. T. Thomas, "Critical Three-Dimensional Arrays of U(93.2)-Metal Cylinders," Nucl. Sci. Eng. 52, 350-359 (November 1973).

10.5-, 15.7-, 20.9-, 26.2-kg cylinders in n^3 arrays (n = 2,3,4), 0- to 15-cm-paraffin reflectors (including 3-sided), effects of Plexiglas, steel between units; also ORNL-TM-868, July 1964.

D. W. Magnuson, "Critical Three-Dimensional Arrays of Neutron-Interacting Units: Part IV. Arrays of U(93.2) Metal Reflected by Concrete and Arrays Separated by Vermiculite and Reflected by Polyethylene," Oak Ridge Y-12 Plant report Y-DR-109 (April 30, 1973).

Eight 21-kg U(93.2) cylinders, 16-in.-thick concrete reflector; bonded vermiculite in arrays with 6-in.-polyethylene reflector.

J. T. Thomas, "Experimental and Calculated System Criticality," *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 149-175.

Recapitulation of data on Oak Ridge arrays, two and three U(93.2) disks on same axis; 5.2-, 10.5-, 15.7-, 20.9-, 26.2-kg U(93.2) metal cylinders, n^3 arrays (n = 2, 3, 4); 5-liter $U(92.6)O_2(NO_3)_2$ solution cylinders at $H/^{235}U$ = 59, 92, 440, planar and n^3 arrays (n = 2, 3, 4, 5); 24-cm-diam by 152-cm-high $U(4.9)O_2F_2$ solution cylinders, planar arrays of 5 to 27 units (see IV.A.1).

J. T. Mihalczo and J. J. Lynn, "Multiplication Measurements with Highly Enriched Uranium Metal Slabs," Oak Ridge National Laboratory report ORNL-CF-59-7-87 (July 27, 1959).

1 by 8 by 10-in. U(93) slabs, three-dimensional arrays at 11-, 12-, 15-in. spacing, 1-in.-Plexiglas reflector.

B. Pu

O. C. Kolar, H. F. Finn, and N. L. Pruvost, "Livermore Plutonium Array Program: Experiments and Calculations," Nucl. Technol. **29**, 57-72 (April 1976).

3-, 6-kg α-Pu units, planar arrays with polyethylene reflector, n^3 arrays (n = 2, 3, 4) bare or partially reflected, effect of mock HE moderator; also UCRL-51041, May 10, 1971, and UCRL-50175, December 22, 1966.

J. Bouly, R. Caizergues, E. Deilgat, M. Houelle, and L. Maubert, "Neutron Interaction in Air of Cylindrical Containers Holding either Uranium or Plutonium Solutions," (in French) French Commissariat of Atomic Energy report CEA-R-3946 (March 1970).

Two, three, or four 300-, 256-mm-diam Pu-solution cylinders, 115, 152 g Pu/liter; two 300-mm-diam ^{235}U-solution cylinders at 81, 90, 110 g ^{235}U/liter; also dissimilar cylinders (see IV.A.1).

C. Clouet d'Orval, E. Deilgat, M. Houelle, and P. Lécorché, "Experimental Research in France on Criticality Problems," (in French) *Criticality Control of Fissile Materials*, Proc. Stockholm Symposium (IAEA, Vienna, 1966) pp. 193-213.

Valduc results: Pu solutions, 20 to 190 g Pu/liter, 30-cm-diam cylinder; 150-cm by 120-cm by 10-cm-thick slab; 50-cm-o.d. by 35-cm-i.d., 50-cm-o.d. by 30-cm-i.d., 50-cm-o.d. by 20-cm-i.d. annuli; two interacting 50-cm-o.d. by 30-cm-i.d. annuli; reflectors various combinations of air, water, with and without Cd (see II.D.1).

D. Breton, P. Lécorché and C. Clouet d'Orval, "Criticality Studies," (in French) Proc. Intern. Conf. Peaceful Uses At. Energy, 3rd, Geneva, 1964 (United Nations, New York, 1965) Vol. 13, pp. 234-243.

Saclay: solutions at 60 g Pu/liter and ~30 to 100 g ^{235}U/liter as U(90) in bare 42-cm-diam cylinder and water-reflected 30-cm-diam cylinder; also spaced reflectors, interaction of two 10-cm-diam cylinders with one at 30-cm diam; Dijon: Pu solution in 50-cm-o.d. by 30-cm-i.d. annulus, interaction of two annuli (see II.A.1 and II.D.1).

C. L. Schuske, C. L. Bell, G. H. Bidinger, and D. F. Smith, "Industrial Criticality Measurements on Enriched Uranium and Plutonium, Part II," Rocky Flats Plant report RFP-248 (January 10, 1962).

~2 kg δ-Pu buttons, ~2.5-in.-diam, three-dimensional array on concrete (other systems too subcritical).

C. ^{233}U

R. C. Lloyd, E. D. Clayton, and J. H. Chalmers, "Criticality of Arrays of ^{233}U Solution," Nucl. Appl. 4, 136-141 (March 1968).

4.5-in.-i.d. by ~11.5-in.-high $^{233}UO_2(NO_3)_2$ solution bottles, 330 g ^{233}U/liter, to 4 by 4, 3 by 3 by 2 arrays, bare, Plexiglas reflector, effect of 0- to 2.5-in. Plexiglas between bottles.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978—777-089/83