

150
3-21-80

LA-7170-MS, Suppl.

DR. 930

Informal Report

MASTER

Experimental Criticality Specifications

Update Through 1979

University of California



LOS ALAMOS SCIENTIFIC LABORATORY

Post Office Box 1663 Los Alamos, New Mexico 87545

An Affirmative Action/Equal Opportunity Employer

**This report was not edited by the Technical
Information staff.**

**This report was prepared as an account of work sponsored
by the United States Government. Neither the United States
nor the United States Department of Energy, nor any of their
employees, nor any of their contractors, subcontractors, or
their employees, makes any warranty, express or implied, or
assumes any legal liability or responsibility for the accuracy,
completeness, or usefulness of any information, apparatus,
product, or process disclosed, or represents that its use would
not infringe privately owned rights.**

UNITED STATES

Experimental Criticality Specifications

Update Through 1979

Compiled by
Hugh C. Paxton

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.



EXPERIMENTAL CRITICALITY SPECIFICATIONS

Update Through 1979

Compiled by

Hugh C. Paxton

ABSTRACT

A table of contents for LA-7170-MS is provided, and publications of criticality specifications that appeared in 1978 and 1979 are listed.

INTRODUCTION

An incentive for this supplement was the omission of a table of contents from the original document. Without this table, the organization is not clear and part of the document's value is lost. Further, there is the opportunity to include in this supplement items published in 1978 and 1979.

Since LA-7170-MS was issued, a more complete criticality bibliography was published by Brian L. Koponen, Thomas P. Wilcox, and Viktor E. Hampel of the Lawrence Livermore Laboratory. It is UCRL-52769, Vols. 1, 2, and 3, entitled, "Nuclear Criticality Experiments from 1943 to 1978, an Annotated Bibliography." Volume 1 consists of a main listing, Volume 2 of lookup tables, and Volume 3 of a subject index. LA-7170-MS with Supplement may still be useful as a convenient abbreviation of the LLL documents when only sources of experimental criticality specifications are desired.

TABLE OF CONTENTS OF LA-7170-MS

	<u>Page</u>
INTRODUCTION.	1
I. COMPILATIONS.	1
II. SIMPLE UNITS.	2
A. U(≥ 90).	2
1. Solutions, Slurries	2
2. Poisoned Solutions.	4
3. Hydrogenous Compacts, Mixtures.	4
4. Nonhydrogenous Moderators	5
5. Reflector Moderators.	7
6. Unmoderated Compounds, Mixtures	8
7. Metal	9
8. Metal with Solution	11
B. U(10 to 90)	
1. Solutions (H ₂ O and D ₂ O), Hydrogenous Mixtures . . .	11
2. Metal, Nonhydrogenous Mixtures.	13
C. U(< 10)	
1. Solutions, Hydrogenous Mixtures	15
2. Metal, Nonhydrogenous Mixtures.	16
D. Pu	
1. Solutions, Hydrogenous Compacts, Mixtures	17
2. Poisoned Solutions, Mixtures.	18
3. Nonhydrogenous Mixtures	19
4. Metal	20
E. PuO ₂ -UO ₂ Mixtures.	21
F. Metallic Pu with U(93)	22
G. ²³³ U	22
III. MODERATED LATTICES.	23
A. Hydrogenous.	23
1. Enriched U.	23
2. U(nat).	26
3. Pu.	27
4. ²³³ U.	27

TABLE OF CONTENTS OF LA-7170-MS (Cont.)

B.	D ₂ O	27
C.	Be or BeO	29
D.	Graphite	29
IV.	INTERACTING UNITS	30
A.	Enriched U	30
	1. Solutions, Mixtures	30
	2. Metal	31
B.	Pu	31
C.	²³³ U	32

PUBLICATIONS IN 1978 AND 1979

I. COMPILATIONS

U. P. Jenquin and S. R. Bierman, "Benchmark Experiments to Test Plutonium and Stainless Steel Cross Sections," Pacific Northwest Laboratory report PNL-2273-- NUREG/CR-0210 (June 1978).

Benchmark critical specifications selected from the literature, 16 homogeneous Pu (solutions, 2 in ss spheres; compacts, or metal) and 28 water-moderated lattices (Al-Pu, UO_2 -Pu O_2 , or UO_2 for comparison of ss and Al clad).

II. SIMPLE UNITS

A. U(≥ 90)

1. Solutions, Slurries

R. E. Rothe and I. Oh, "Benchmark Critical Experiments on High-Enriched Uranyl Nitrate Solution Systems," Nucl. Technol. 41, 207-225 (December 1978).

$U(93)O_2(NO_3)_2$ solution, 55 to 370 g U/liter, single 27.9- to 50.7-cm-diam cylinders, clustered 16.1- and 21.1-cm-diam cylinders in air, unreflected and in concrete or plastic enclosures of 122-cm inside dimension (see IV.A.1.).

B. U(10 to 90)

2. Metal, Nonhydrogenous Mixtures

G. E. Hansen and H. C. Paxton, "A Critical Assembly of Uranium Enriched to 10% in Uranium-235," Nucl. Sci. Eng. 72, 230-236 (November 1979).

53.3-cm-diam x 55.9-cm-long metal core, homogeneous U(10) on axis surrounded by interleaved U(nat) and U(93) plates averaging U(10); depleted U reflector, 15.2-cm-thick on radius, 20.3-cm-thick at ends.

C. U(< 10)

1. Solutions, Hydrogenous Mixtures

G. Tuck and I. Oh, "Benchmark Critical Experiments on Low-Enriched Uranium Oxide Systems with H/U = 0.77," Rocky Flats Plant report NUREG/CR-0674 (August 1979).

77-cm cube of damp $U(4.46)_3O_8$, reflected by 25.4-cm-thick concrete or methyl methacrylate or 0.8-cm-thick Al plus steel; criticality required near-critical "driver" of U(93) metal or solution; no correction for gap at parting plane, space about driver or access slot.

D. Pu

3. Nonhydrogenous Mixtures

S. K. Battacharyya, D. C. Wade, R. G. Bucher, D. M. Smith, R. D. McKnight, and L. G. LeSage, "A Critical Experimental Study of Integral Physics Parameters in Simulated Liquid-Metal Fast Breeder Reactor Meltdown Cores," Nucl. Technol. 46, 517-524 (Mid-December 1979).

Reference core 88.4-cm-equilateral cylinder described as "LMFBR outer-core composition" (14 vol % U + Pu containing 22% Pu, Na, ss, presumably Fe_2O_3) reflected by thick $\text{UO}_2 + \text{Na} + \text{ss}$ in ss. In 38-cm-diam zone, effects of voiding Na, then concentrating fuel at twice density in various locations within the zone.

4. Metal

G. E. Hansen and H. C. Paxton, "Thor, A Thorium-Reflected Plutonium-Metal Critical Assembly," Nucl. Sci. Eng. 71, 287-293 (September 1979).

A δ -Pu sphere in a 53.3-cm-equilateral Th cylinder, one-dimensional specifications are deduced.

E. PuO_2 - UO_2 Mixtures

S. R. Bierman, B. M. Durst, and E. D. Clayton, "Critical Experiments Measuring the Reactivity Worths of Materials Commonly Encountered as Fixed Neutron Absorbers," Nucl. Sci. Eng. 65, 41-48 (January 1978).

PuO_2 - $\text{U}(\text{nat})\text{O}_2$ -polystyrene compacts, 14.6 wt % PuO_2 in $t\text{PuO}_2 + \text{UO}_2$, $H/(\text{Pu} + \text{U}) = 30.6$, plexiglas reflector; effects of ss, boron ss, depleted U, boral, Cd, Pb sheets of various thicknesses on midplane; also as driver for other compacts.

III. MODERATED LATTICES

A. Hydrogenous

1. Enriched U

J. C. Manaranche, D. Mangin, L. Maubert, G. Colomb, and G. Pouillot, "Critical Experiments with Lattices of 4.75-wt%- ^{235}U -Enriched UO_2 Rods in Water," Nucl. Sci. Eng. 71, 154-163 (August 1979).

0.79-cm-diam $\text{U}(4.75)\text{O}_2$ rods, square pitches 1.26 cm to 2.52 cm, triangular pitches 1.35 cm to 2.26 cm, spanning optimum moderation.

S. R. Bierman, B. M. Durst, and E. D. Clayton, "Criticality Experiments with Subcritical Clusters of 2.35 wt% and 4.29 wt% ^{235}U Enriched UO_2 Rods in Water with Uranium or Lead Reflecting Walls," Pacific Northwest Laboratory report PNL-2827 -- NUREG/CR-0796 (April 1979).

1.26-cm-diam $\text{U}(4.29)\text{O}_2$ rods at 2.54-cm pitch, 1.12-cm-diam $\text{U}(2.35)\text{O}_2$ rods at 2.03-cm pitch, 3 in-line clusters, spacing adjusted to criticality with 7.7-cm-thick depleted U or 10.2-cm-thick Pb slabs in the water reflector at various distances from the line of clusters; benchmarks for shipping-cask design.

S. R. Bierman, B. M. Durst, and E. D. Clayton, "Critical Separation Between Subcritical Clusters of Low Enriched UO_2 Rods in Water with Fixed Poisons," Nucl. Technol. 42, 237-249 (March 1979).

1.26-cm-diam $\text{U}(4.29)\text{O}_2$ rods at 2.54-cm pitch, 1.12-cm-diam $\text{U}(2.35)\text{O}_2$ rods at 2.03-cm pitch, critical single clusters and 3 in-line clusters, unpoisoned; effects of Cd, Al, Zircaloy between clusters; benchmarks for shipping-cask design.

3. Pu

S. R. Bierman, B. M. Durst, E. D. Clayton, R. I. Scherpelz, and H. T. Kerr, "Critical Experiments with Fast Test Reactor Fuel Pins in Water," Nucl. Technol. 44, 141-151 (June 1979).

0.5-cm-diam $\text{PuO}_2\text{-U}(\text{nat})\text{O}_2$ rods, 19.8 wt% Pu(11.5% ^{240}Pu), square lattice pitches from 0.77 to 1.90 cm.

IV. INTERACTING UNITS

A. Enriched U

1. Solutions, Mixtures

R. E. Rothe and I. Oh, "Benchmark Critical Experiments on High-Enriched Uranyl Nitrate Solution Systems," Nucl. Technol. 41, 207-225 (December 1978).

$\text{U}(93)\text{O}_2(\text{NO}_3)_2$ solution, 55 to 370 g U/liter, single 27.9- to 50.7-cm-diam cylinders, clustered 16.1- and 21.1-cm-diam cylinders in air, unreflected and in concrete or plastic enclosures of 122-cm inside dimension (see II.A.1).