REFERENCE 56

H. R. RALSTON, "CRITICAL MASSES OF SPHERICAL SYSTEMS OF ORALLOY REFLECTED IN BERYLLIUM," UNIVERSITY OF CALIFORNIA RADIATION LABORATORY REPORT UCRL-4975 (OCTOBER 1957).

UCRL-4975
Criticality Studies

UNIVERSITY OF CALIFORNIA
Radiation Laboratory, Livermore Site
Livermore, California

Contract No. W-7405-eng-48

CRITICAL MASSES OF SPHERICAL SYSTEMS OF ORALLOY REFLECTED IN BERYLLIUM

H. Robert Ralston

October 10, 1957

Printed for the U. S. Atomic Energy Commission

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

CRITICAL MASSES OF SPHERICAL SYSTEMS OF ORALLOY REFLECTED IN BERYLLIUM

H. Robert Ralston

University of California Radiation Laboratory
Livermore Site

October 10, 1957

ABSTRACT

The critical thickness of beryllium reflector was determined for oralloy (uranium, enriched to 93.17% U^{235}) spheres ranging from 10.765 kg to 32.654 kg. Four points which were determined by other experimenters were normalized to the data and are included in the curves.

CRITICAL MASSES OF SPHERICAL SYSTEMS OF ORALLOY REFLECTED IN BERYLLIUM

H. Robert Ralston

University of California Radiation Laboratory
Livermore Site

October 10, 1957

Introduction

The critical thickness of beryllium reflector was determined for oralloy spheres ranging from 10.765 kg to 32.654 kg.

The critical thicknesses of beryllium in all cases was determined by extrapolating the inverse leakage multiplication to zero, at which point the corresponding beryllium thickness is that which will be required to bring the assembly to delayed critical. No assembly was operated at critical since the control system used did not permit a multiplication in excess of 100. Four points on a core mass vs reflector thickness curve for beryllium were determined by other experimenters and are included in the table of data as indicated. All of the data that is presented in Fig. 1 has been corrected to a U^{235} concentration of 93.17% and an oralloy density of 18.6 g/cc in accordance with the following relationships: U^{235} critical mass $\propto (U^{235}\ \text{concentration})^{-0.7}$ and U^{235} critical mass $\propto (\text{oralloy density})^{-x}$. Values of x as a function of beryllium thickness are given in Fig. 2 (25 cm of Be is considered to be infinite for purposes of the plot). The material that was used at this laboratory was composed of a central sphere of oralloy which contained a 7/16-inch spherical cavity in its center for the inclusion of a PoBe neutron source. The over-all worth of this missing material has been assumed to be six times the amount of material which was removed.

Experimental Procedure

The oralloy used consisted of hemispherical nesting shells which allowed 10.765-kg, 16.267-kg, 21.780-kg, 27.991-kg, and 32.654-kg spheres to be constructed. The beryllium reflector consisted of a similar set of nesting shells which allowed reflector to be added in approximately 0.25-inch steps.

The maximum allowable multiplication for the particular control system was 100. Since the beryllium thickness was variable only in discrete steps, some of the assemblies had to be stopped at relatively low multiplications because the next available beryllium thickness would have caused the multiplication to exceed 100. The lowest multiplication was 29, which corresponds to an accuracy of extrapolation to critical of about 3.5%.

The counting equipment consisted of two CH_2-moderated LiI, scintillation counters and two Hanson-McKibben-type BF_3 proportional counters. A PoBe source supplied neutrons to the assembly and served as a calibration standard for the counters.

Results

The data is summarized in Table I and shown graphically in Fig. 1. The limits of error are also shown in Table I.

Table I. Summary of Results

$\%U^{235}$	Oy (g/cc)	M_cOy (kg)	Corrected M_cOy (kg)	Be critical thickness (inch)
93.17	18.49	10.765	10.6*#	7.98 ± .16
93.5[1]	18.8	15.1	15.4*	4.0
93.17	18.58	16.267	16.187#	3.65 ± .07
93.17	18.59	21.780	21.700#	2.14 ± .03
93.5[1]	18.8	22.3	22.8*	2.0
93.17	18.59	27.991	27.911#	1.285 ± .013
93.5[1]	18.8	31.2	31.9*	1.0
93.17	18.59	32.654	32.574#	0.875 ± .026
93.8[1]	18.8	51.3	52.4*	0.000

* Corrected to a U^{235} concentration of 93.17 % and an oralloy density of 18.6 g/cc, as indicated in the text.

Corrected for a central source cavity 7/16 inch in diameter, assuming a central material worth of 6 times the mass removed.

[1] G. A. Graves and H. C. Paxton, "Critical Masses of Oralloy Assemblies," Nucleonics, June 1957, p. 90-92.

/jm

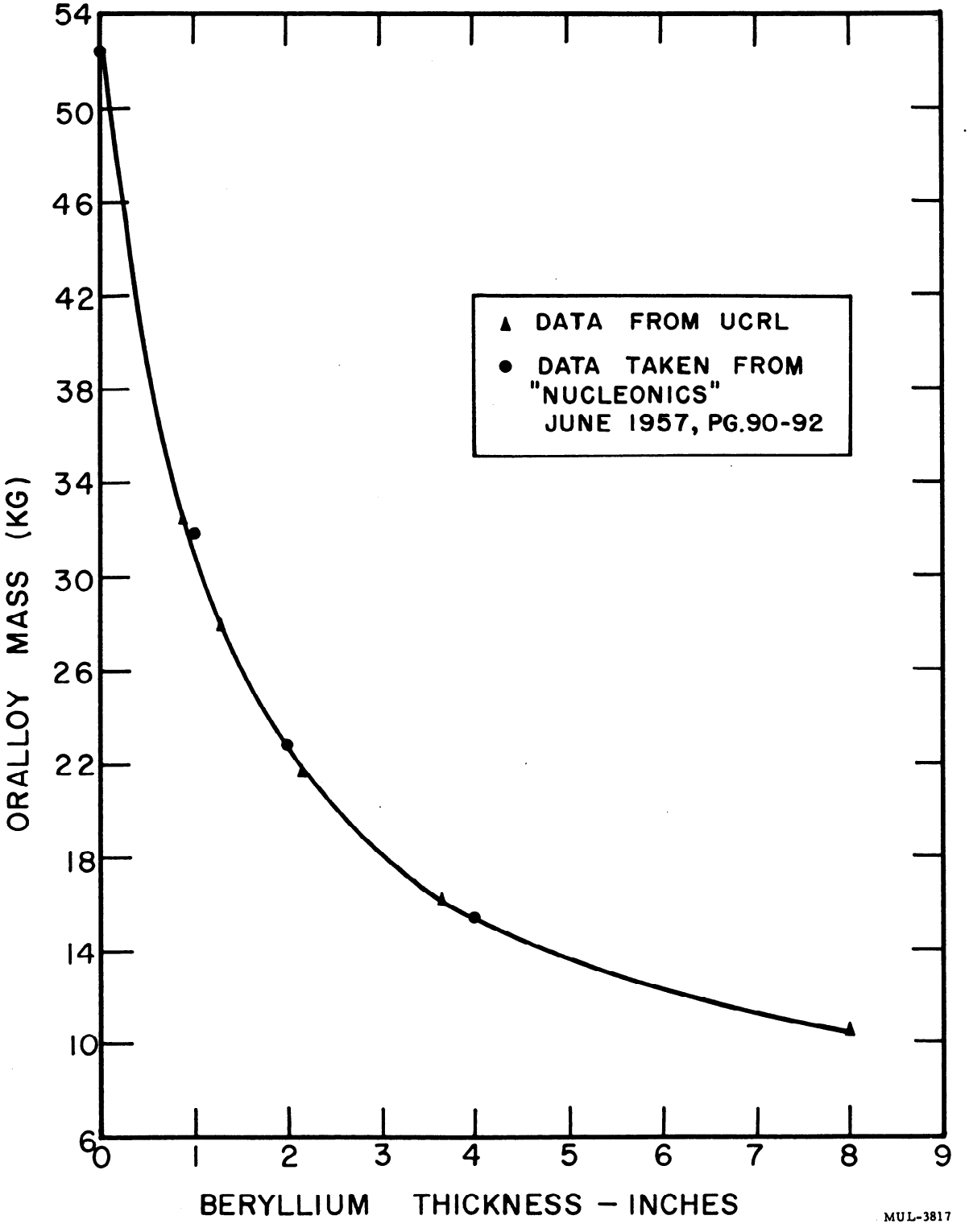

Fig. 1. Oralloy mass vs beryllium reflector for delayed critical spherical assemblies. Oralloy density = 18.6 g/cc; oralloy concentration of U^{235} = 93.17%; beryllium density = 1.84 g/cc.

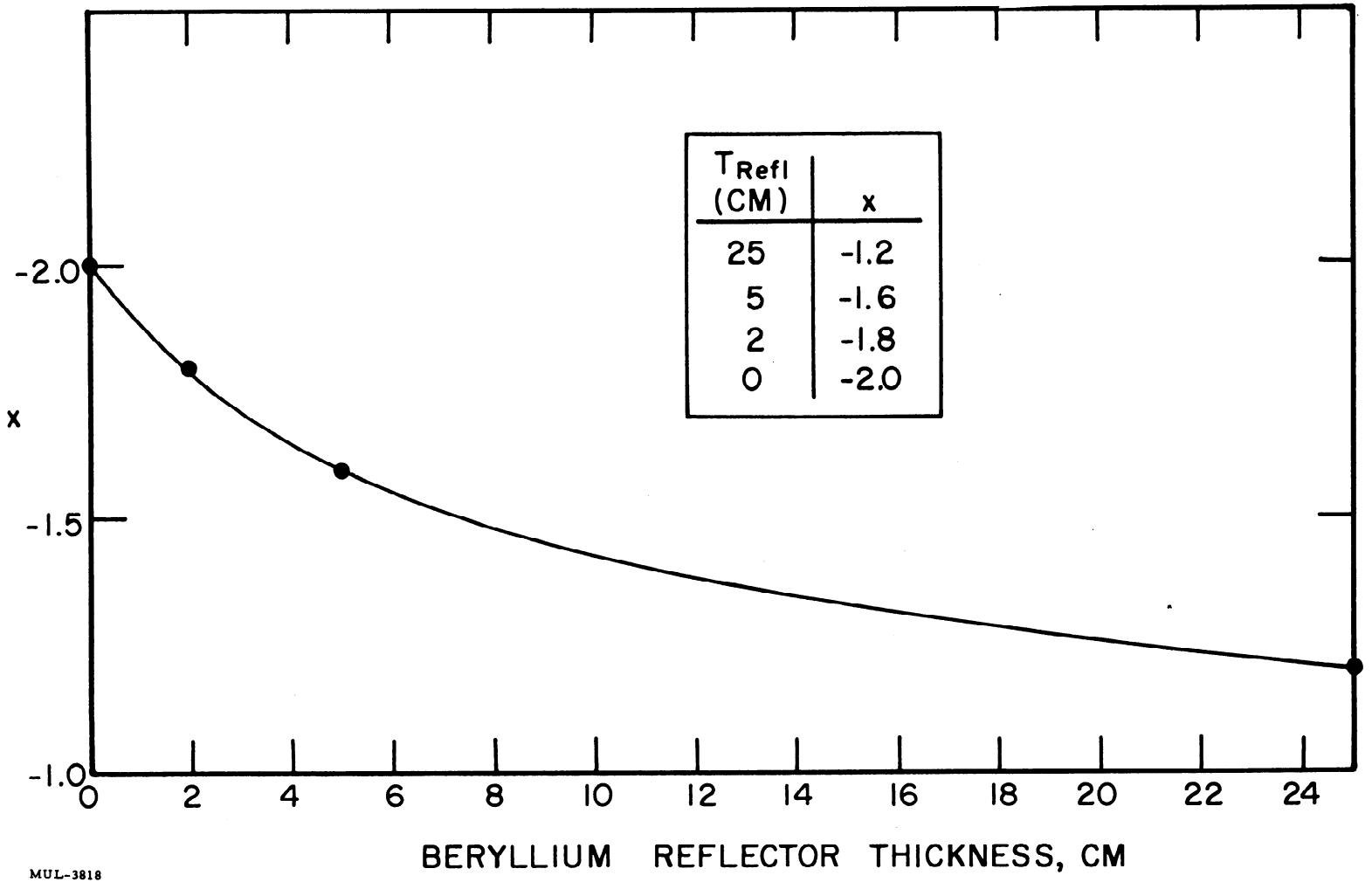

Fig. 2. Values of x vs beryllium reflector thickness in the relationship, U^{235} critical mass $\propto$ (Oy density)$^{-x}$. (Data supplied by L. S. Germain of UCRL-Livermore).