MASTER

TITLE: Reactivity Coefficients of Heavy Isotopes
in LASL's Fast Critical Assemblies

AUTHOR(S):   C. C. Byers
G. E. Hansen
J. J. Koelling
E. A. Plassmann
D. R. Smith
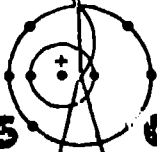
SUBMITTED TO: ANS Annual Meeting, San Diego, CA
June 18-23, 1978

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

An Affirmative Action/Equal Opportunity Employer

REACTIVITY COEFFICIENTS OF HEAVY ISOTOPES IN LASL'S
FAST CRITICAL ASSEMBLIES

by

C. C. Byers, G. E. Hansen, J. J. Koelling, E. A. Plassmann
and D. R. Smith, University of California, Los Alamos
Scientific Laboratory, Los Alamos, New Mexico 87545

We are attempting a systematic investigation of heavy
isotope behavior in the Pajarito fast-neutron critical
assemblies. Included will be central reactivity coeffi-
cient measurements and fission rate measurements in natural
uranium reflected plutonium and 93%-enriched uranium metal
assemblies and in Big Ten, a depleted uranium reflected
10%-enriched uranium metal assembly.

A few reactivity coefficients have recently been
measured for ^{235}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{242}Pu, and ^{241}Am.
The experimental technique has been described by Stubbins,
Barton, and Loandier,[1] and preliminary results are listed
in the Table.

Similar data for some of these isotopes in unreflected
plutonium (Jezebel) and 93%-enriched uranium (Godiva) have
previously been reported.[1-3]

Central reactivity coefficients are closely related to
neutron net-production cross sections of the samples which
in turn are related to criticality. By establishing the
bias in the computed coefficients, one may obtain improved

estimations of critical dimensions. Six group cross section sets, developed for the above isotopes, have been used in this fashion to give the following bare sphere critical mass estimates.

$m_c(^{238}Pu) \approx 12$ kg, $m_c(^{242}Pu) \approx 90$ kg, and $m_c(^{241}Am) \approx 58$ kg.

It is hoped that these data will be useful to the standards work group which is currently developing a criticality safety standard for operations with the actinide elements.

TABLE
Central Reactivity Coefficient Ratios in
Flattop-Pu, Flattop-U(93), and Big Ten

Isotope	Flattop-Pu	Flattop-U(93.2)	Big Ten
^{235}U	0.524±0.007	0.528±0.010	0.585±0.006 →.63°
^{237}Np	–	0.42 ±0.02	0.065±0.006 →.06°
^{238}Pu	0.899±0.014	0.889±0.014	0.661±0.018 →.63°
^{239}Pu	≡1.00	≡1.00	≡1.00
^{242}Pu	0.494±0.010	0.479±0.010	–
^{241}Am	0.605±0.011	0.530±0.010	–

References

1. W. F.Stubbins, D. M. Barton, and F. D. Lonadier, "The Neutron-Production Cross Section of ^{238}Pu in a Fast Spectrum," Nucl. Sci. Eng. 25, 377-382, (1966).

2. D. M. Barton, "Central Reactivity Contributions of ^{244}Cm, ^{239}Pu and ^{235}U in a Bare Critical Assembly of Plutonium Metal," Nucl. Sci. Eng. 33, 51-55, (1968).

3. L. B. Engle, G. E. Hansen, and H. C. Paxton, "Reactivity Contributions of Various Materials in Topsy, Godiva, and Jezebel," Nucl. Sci. Eng. 8, 543-560, (1960).