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THE AVERAGE FISSION CROSS SECTION OF U^{233} , U^{234} , AND U^{236}
IN THE FAST REACTOR NEUTRON SPECTRUM.

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E. Jurney

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LA-1250

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21

STANDARD DISTRIBUTION

Argonne National Laboratory	22 - 33
Armed Forces Special Weapons Project	34
Atomic Energy Commission, Washington	35 - 40
Brookhaven National Laboratory	41 - 44
Bureau of Ships	45
Carbide & Carbon Chemicals Company (K-25 Plant)	46 - 47
Carbide & Carbon Chemicals Company (Y-12 Area)	48 - 49
Chicago Patent Group	50
Chief of Naval Research	51
Columbia University (Havens)	52
duPont Company	53 - 56
General Electric Company, Richland	57 - 60
Hanford Operations Office	61
Idaho Operations Office	62 - 63
Iowa State College	64
Knolls Atomic Power Laboratory	65 - 68
Mound Laboratory	69 - 70
National Advisory Committee for Aeronautics	71
Naval Research Laboratory	72
New York Operations Office	73 - 74
North American Aviation, Inc.	75 - 77
Oak Ridge National Laboratory (X-10)	78 - 85
Patent Branch, Washington	86
Savannah River Operations Office	87
UCLA Medical Research Laboratory (Warren)	88
USAF - Headquarters	89
U. S. Naval Radiological Defense Laboratory	90
University of California Radiation Laboratory	91 - 93
Westinghouse Electric Corporation	94 - 97
Wright-Patterson Air Force Base	98 - 100
Technical Information Service, Oak Ridge	101 - 115

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THE AVERAGE FISSION CROSS SECTION OF U^{233} , U^{234} , AND U^{236}
IN THE FAST REACTOR NEUTRON SPECTRUM.

The report to follow gives results of a series of fission cross section measurements in the high-energy neutron spectrum of the fast reactor. These measurements are a continuation of those reported in LA-1201, and the same equipment and counting techniques were employed for the present experiments.

I. Weighing of Foils.

The isotopic fractions of the foils used in the measurements are shown in the following table:

<u>U isotope</u>	<u>25 Std</u>	<u>23 Foil</u>	<u>24 Foil</u>	<u>26 Foil</u>
233	-	0.982	-	-
234	-	-	0.941	.0064
235	.9985	-	0.0445	0.588
236	-	-	-	0.375
238	-	0.018	0.0151	0.03

The tabulated fractions are all results of Oak Ridge mass spectrographic analyses, except in the case of the U^{233} foil, for which the figure of 98.2% is an Oak Ridge figure, with the remaining 1.8% of the content assumed to be U^{238} .

Each of the three unknown foils was "weighed" by determining the amount of thermal fissionable material on them relative to the amount

of 25 on a foil made of 99.85% material. This procedure required the use of thermal fission cross sections for U^{233} and U^{234} , but it is a much better one for the foils involved than that of alpha counting because of the low specific α -activity of U^{235} . The values of these cross sections which were used were

$$\sigma_{th}(23)/\sigma_{th}(25) = 0.933 \pm 0.03 \quad (\text{CK2737}) \quad \text{and}$$

$$\sigma_{th}(24)/\sigma_{th}(25) = 0.0038 \quad (\text{LA140A}).$$

The ratio R_{th} of the thermal fission rate of the foils containing U^{233} , U^{234} , and U^{236} to that of the U^{235} "standard" foil was determined and inserted into an appropriate equation of the following kind:

$$R_{th} = \frac{N_x}{N_{25}} \left(f(23) \frac{\sigma_{th}(23)}{\sigma_{th}(25)} + f(24) \frac{\sigma_{th}(24)}{\sigma_{th}(25)} + f(25) \right),$$

which yielded values of N_x/N_{25} , the ratio of the number of fissionable atoms on each foil to the number of 25 atoms on the standard foil.

Values of R_{th} and N_x/N_{25} are shown in the following table:

Foil	R_{th}	N_x/N_{25}
23	0.2478 \pm .00053	0.2705 \pm .0085
24	0.0550 \pm .00022	1.239 \pm .005
26	0.7392 \pm .0036	1.257 \pm .0016

II. Fast Neutron Fission Cross Sections.

Fast neutron fission counting was carried out, as described in LA-1201, with the foils inserted in the fast reactor 5W port, approxi-

mately 1 3/4" from the edge of the reactor's active material. The determination of R_f , the ratio of the fast neutron fission rate of one of the unknown foils to that of the 25 foil, together with the values of N_x/N_{25} previously determined makes it possible to solve the following equation for $\bar{\sigma}_f(x)/\bar{\sigma}_f(25)$:

$$R_f(x) = \frac{N_x}{N_{25}} \left(f(23) \frac{\bar{\sigma}_f(23)}{\bar{\sigma}_f(25)} + \dots + f(28) \frac{\bar{\sigma}_f(28)}{\bar{\sigma}_f(25)} \right)$$

The table following lists the measured values of $R_f(x)$ and the corresponding values of $\bar{\sigma}_f(x)/\bar{\sigma}_f(25)$ and $\bar{\sigma}_f(x)$:

Foil (x)	R_f	$\bar{\sigma}_f(x)/\bar{\sigma}_f(25)$	$\bar{\sigma}_f(x)$ (b.)
23	0.4234 ± .00095	1.59 ± .057	2.53 ± .09
24	0.4380 ± .0016	0.327 ± .0017	0.52 ± .003
26	0.7923 ± .0014	0.114 ± .0085	0.181 ± .0135

The average fission cross sections $\bar{\sigma}_f(x)$ in barns are obtained from $\bar{\sigma}_f(x) = 1.59 \frac{\bar{\sigma}_f(x)}{\bar{\sigma}_f(25)}$. This value of the average fission cross section of U^{235} in the reactor spectrum was arrived at by averaging $\sigma(E)$ (LA-994) over the measured spectrum (LA-1234).

The indicated limits of error are based on the r.m.s. counting errors and, in the case of the U^{236} measurement, on the estimated error in the mass analysis of the foil material. Because of the relatively small percentage of U^{236} on this foil, the small error in its determination is responsible for most of the error in the value of the

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cross section. The uncertainty of approximately three percent in $\alpha_{th}(23)/\alpha_{th}(25)$ as given in CK2737 is included in the error shown for $\bar{\sigma}_f(23)/\bar{\sigma}_f(25)$.

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