This method, however, was extremely tedious, requiring 16 technician hours to dejacket three cans, and many pellets were cracked in the process; also, one milling blade could be used for only two cans. Another method in which the cans were melted by means of a resistance heater was also very slow and occasionally left aluminum in large amounts on the pellets, which caused hydrogen to be generated during subsequent processing. When these dejacketing procedures were performed in a manipulator cell, they were cumbersome and time-consuming.

The successful method evolved for dejacketing the pellets consisted in using an rf heater and a work coil made of seven turns of $\frac{1}{4}$-in. copper tubing wound around a quartz tube (Fig. 1). The can was about $\frac{1}{32}$ in. smaller in diameter than the quartz tube. The coil and the quartz liner were installed in a vertical position and the can was lowered into the coil. In approximately 3 min. the bottom of the can melted. Since the can had been heated throughout, the aluminum expanded and allowed the pellets to fall free. Ten cans were dejacketed in 9 technician hours. The pellets were clean and only one was cracked. In this procedure the only piece of equipment put in the manipulator cell was the rf work coil. No attempt was made to decontaminate the work coil because it could be replaced at a cost of one-half craftsman hour.

B. J. MASSEY

Radioisotope Production Department,
  Isotopes Division,
Oak Ridge National Laboratory
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$\gamma - \gamma$ Coincidence Method for Measuring Resonance Escape Probability in U^{238} Lattices

In the usual methods (1–3) of measuring the resonance escape probability or the conversion ratio in U^{238} fueled lattices, it is necessary to determine the cadmium ratio of U^{238} absorptions. The resonance escape probability, for example, is (approximately) related to the cadmium ratio by the expression

$$p = 1/(1 + \rho f\Sigma)$$

where ρ is the cadmium ratio of U^{238} capture, f the thermal utilization, and Σ is the fraction of thermal capture in the fuel which takes place in U^{238}. f and Σ are assumed known from separate experiments and the macroscopic cross sections of the U^{235} and U^{238} in the fuel.

In the measurements, uranium foils (natural or depleted) are irradiated and the U^{238} absorption rates are obtained by one or more of the following techniques: β counting of either the 23 min U^{239} activity or the 2.3 day Np^{239} activity following chemical separation from fission and daughter products; γ counting of the Np^{239} activity without separation (for highly depleted foils); γ counting of the Np^{239} activity following separation.[1] In the γ counting, it is most con-

[1] Kapalas and Heinrich [*Nuclear Sci. and Eng.* **4**, 698 (1958)] have measured capture rates in U^{238} by absolute assay of the Pu^{239} alpha activity following chemical separation.
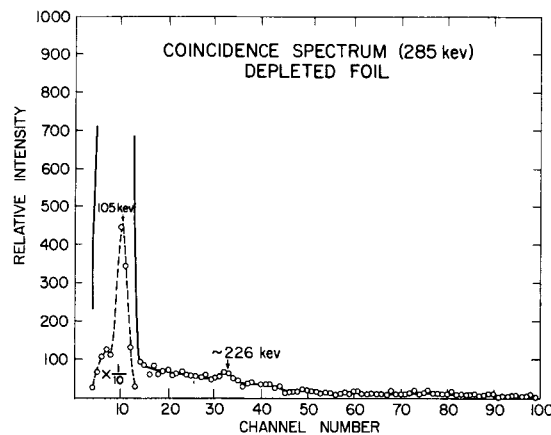

FIG. 1. The spectrum of γ rays in coincidence with the 286-kev radiation. The dotted portion of the curve around 100 kev is shown on a scale reduced by a factor of 10.

TABLE I

Volume H_2O/U	Cd ratio $(U^{239}\ \beta^-)$	Cd ratio $(Np^{239}\ \gamma - \gamma)$
1.5	1.43 ± 0.03	1.39 ± 0.03
2	1.50 ± 0.04	1.56 ± 0.02
3	1.79 ± 0.03	1.76 ± 0.02
4	1.98 ± 0.03	1.98 ± 0.07

venient to count the large peak near 103 kev, which consists mainly of internal conversion x-rays and the 106 kv γ ray (4). If no separation is used, there may also be a considerable contribution to the activity around 100 kev from fission products and the natural activity of U^{238}, which has a γ ray at about 95 kev.

This note describes a technique which does not require chemical work but which eliminates the extraneous activities near 100 kev. The method consists simply of counting coincidences between two of the γ rays in the Np^{239} decay, those at 285 kev and 106 kev (4). A high degree of sophistication in the coincidence circuits is not required, at least for measurements of relative disintegration rates.

In the present work depleted uranium foils approximately 0.010 in. thick were irradiated bare and cadmium covered in lattices of 0.250-in. diameter rods of slightly enriched uranium moderated by water. The use of depleted foils was convenient, but there is no reason to doubt that natural uranium foils would have been equally satisfactory. Four water-uranium volume ratios were used. The lattices were irradiated in a pile leakage flux of about 10^9 n/cm²/sec.

After a wait of a few hours to allow the U^{239} to decay and the Np^{239} to build up, the foils were counted alternately for several hours. Under these conditions, and using $1\frac{1}{2} \times$ 2 in. NaI (Tl) scintillation detectors with a source-detector distance of about 1 cm, the total number of coincidences for each foil was several thousand. The random coincidence rates were below 1% of the true coincidence rates. Actually, a 100-channel analyzer was used to display the spectrum in coincidence with 285-kev pulses. Figure 1 shows the coincidence spectrum up to about 500 kev. The large peak is the 106-kev γ ray, and there is a much weaker

line at 226 kev (4). The continuous "tail" is due to bremsstrahlung from the 485-kev γ ray which feeds the 286-kev level (4). No correction for the contributions of the bremsstrahlung or the Compton shelf of the 226-kev line to the 106-kev line intensity is necessary since these are also proportional to the Np^{239} disintegration rate.

The total number of counts stored between two points on either side of the 106-kev peak was used as a measure of the relative intensity of the line. These points were chosen sufficiently far off the peak so that small instrumental drifts would cause negligible errors. The line intensities for the bare and Cd-covered foils were then corrected for small differences in the weight of the foils and for the decay of the Np^{239} during the counting period to obtain the cadmium ratios.

Table I lists the cadmium ratios obtained by this method and also those previously obtained by β^- counting of the U^{239} after chemical separation. (The results for all four volume ratios are listed simply for purposes of comparison.) Each entry in the table is the average of several runs. The errors are standard deviations of the mean, which were usually somewhat larger than those expected from the counting statistics, because of the weight corrections, small errors in counting geometry, etc. The agreement is seen to be good, and the choice of technique would probably be dictated by the tastes of the experimenter. The coincidence method, however, appears to offer the following advantages: nondestructive use of foils, no interference from extraneous activities, and no chemistry. It has the disadvantages of possibly requiring longer counting times and more elaborate counting equipment, although, as has been mentioned, the coincidence circuit need not be as complex as the setup used in this work.

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RUDOLPH SHER

Brookhaven National Laboratory,
Upton, New York
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