Fig. 1 assuming the neutron temperature to be the same as the thermal-column temperature. The experimental curve is normalized to the calculated value at 577°C.

Also appearing in Fig. 1 is a curve which is to be compared to the activity ratios obtained with the lutetium foils. This curve appears as a broken line and shows the changes in the ratio of the fission product activities of Pu^{239} to those of U^{235} as a function of neutron temperature. These ratios were obtained (*1*) from plutonium and uranium foils which were irradiated in the same manner as the lutetium foils. For the comparison the values obtained with the fission foils have been normalized at 20°C to the curve for the lutetium foils. From a comparison of the slopes of the curves in Fig. 1, it is evident that the lutetium "thermometer" is ~ 7 times more sensitive at room temperature than the Pu^{239}–U^{235} "thermometer" and remains more sensitive up to ~ 400°C.

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Void Coefficient Measurement

A quantity which has proven somewhat difficult to measure for tank type reactors with plate spacing of the order of $\frac{1}{8}$ in. is the void coefficient for voids in the moderator between the plates. It is difficult to simulate the voids properly. Methods have been used which depended on a knowledge of the compositions of plastics such as polyethylene and involved calculation of the reduction in hydrogen density when the material was inserted between fuel plates (*1*). Use has also been made of Styrofoam. In the first case a large amount of foreign material must be inserted in the core per unit of equivalent void; in the second case the variations in effective void fraction with pressure, time under water, and surface-to-volume ratio of the Styrofoam are unknown and enters the calculations directly if the effective void is calculated from physical dimensions.

If, however, the void equivalent of Styrofoam is measured by measuring the buoyant force on a submerged fuel element loaded with it, considerably greater precision can be obtained. It can be shown that

$$\Delta V = \frac{\Delta W}{\rho_{\mathrm{H_2O}}} \left(\frac{1 - k_{\mathrm{H}}\delta}{1 - k\delta} \right)$$

where ΔV is the equivalent void introduced, ΔW is the buoyant force, k_{H} is the relative hydrogen atom density of polystyrene with respect to water, k is its relative weight density, and δ is the volume fraction of Styrofoam which is solid material. It will be found that this expression has only a slow and indirect dependence on δ for Styrofoam of the usual characteristics. One can construct a simple balance and measure ΔW *in situ*, using a long wire to suspend the fuel element under water near the grid plate of the reactor. As a counterweight one can use a second fuel element. A simple measurement of the weight required to rebalance the two when Styrofoam is added to one of them gives the void equivalent directly to an approximation sufficiently good for most purposes.

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Dejacketing Pellets Using RF Heat

Pellets of Be_3N_2 are irradiated in aluminum cans to produce C^{14}. Removing these pellets from the cans is difficult because they swell against the wall, the characteristics of aluminum are changed by radiation, and radiation from cobalt impurity in the target material is high, 5 to 10 r/hr per can at 1-ft gamma activity.

The pellets cannot be dejacketed by chemical methods because of the danger of introducing normal carbon. Therefore several mechanical methods were tried. One involved sawing the cans lengthwise and then sawing the ends off.

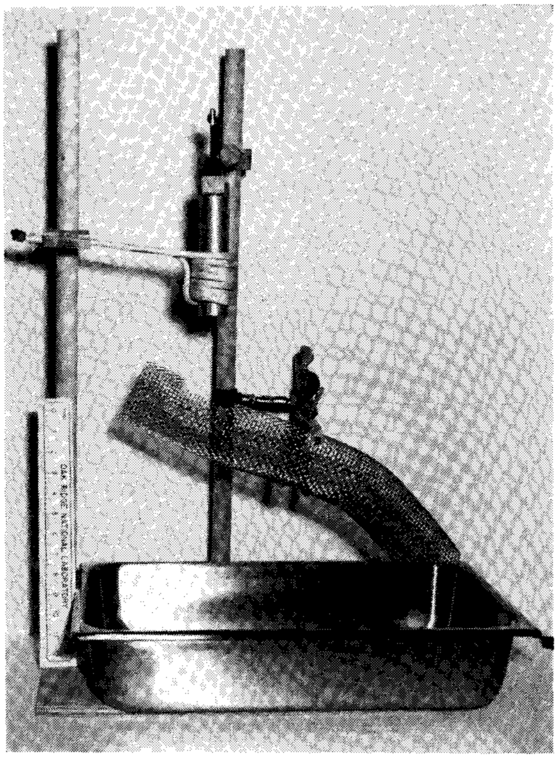

Fig 1. In cell set-up.

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.

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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 convenient 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.

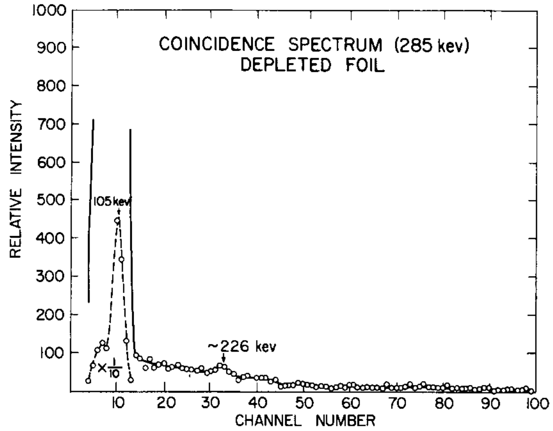

FIG. 1. The spectrum of γ rays in coincidence with the 286-kev radiation. The dotted portion of the curve around 100 kev is shown on a scale reduced by a factor of 10.

TABLE I

Volume H_2O/U	Cd ratio (U^{239} β^-)	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

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

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[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.