is increased (8) both in uranium and in the U-Mo alloy. This would seem to rule out microcracks and indicate metastable alloys, possibly with impurity atoms. Clearly, it would require extensive analytical and metallurgical work to test this hypothesis.

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Attenuation of 14-Mev Neutrons in Water and in 6-In. Lead and Water

Caswell *et al.* (*1*) have measured the fast neutron dose from a 14.1 Mev source in water employing a proportional counter dosimeter. As a heavy element (e.g., Pb or Bi) is sometimes used immediately after the source of fast neutrons to improve the neutron shielding properties of water, experimental distributions of fast (above 1 Mev) and resonance (1.46 ev) neutron flux in 6-in. Pb + water and pure water media have been obtained.

The experimental setup consisted of an aluminum tank (5 ft long, 3 ft wide, and 4 ft deep) filled with demineralized water as shown in Fig. 1. Neutrons of 14.1 Mev were obtained from the $H^3(d,n)He^4$ reaction. The deuteron beam was accelerated to 200 kev in a Cockroft-Walton type accelerator. The tritium target (2.5 cm in diameter) was kept under 2 ft of water in a tank, as shown in Fig. 1. For this an extension consisting of a thin aluminum tube, 3.8 cm in diameter, was joined to the main acceleration tube. The extension tube was insulated from water by wrapping a thin alkathene sheet around the tube. The target was cooled by circulating cold water in-between the alkathene sheet and the aluminum tube. All the measurements were made along the length (5 ft side) at 90° to the incident deuteron beam, the target being 1½ ft from one end and 3½ ft from the other. In order to check whether the dimensions of the experimental tank were large enough, additional tanks (6 in. wide) were kept on either side of the main tank. No change in the response of In detectors, irradiated at different distances, was noticed when the additional tanks were also present. For measurements in 6-in. Pb + H_2O medium, Pb bricks were piled up next to the target tube to form a wall of dimensions 6 in. thick by 3 ft wide and 4 ft high.

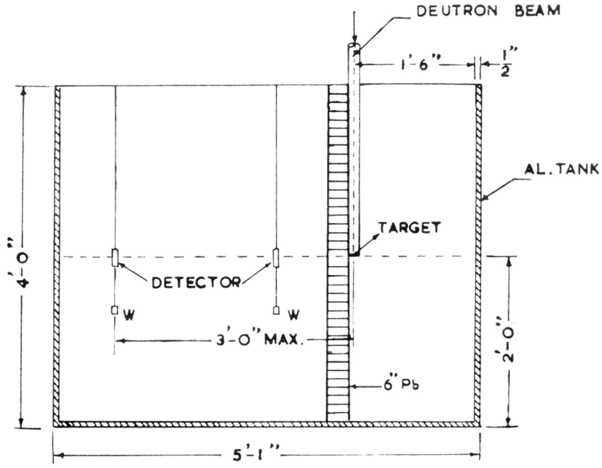

FIG. 1. Experimental setup for 6-in. Pb + H_2O medium. *W* refers to small iron weights used to keep the detectors straight.

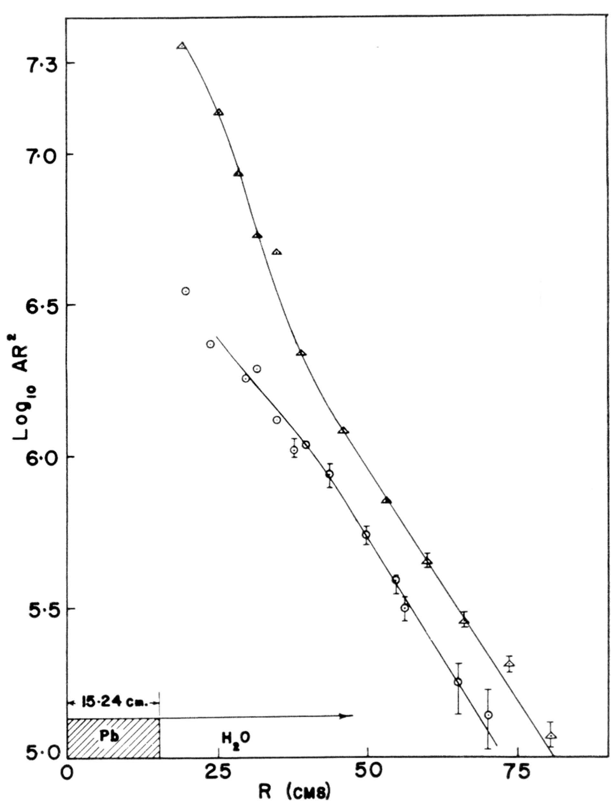

FIG. 2. Log AR^2 (in arbitary units) as a function of distance R (in cm) in 6-in. Pb + H_2O medium. △ Indium detector (1.46 ev). ○ Phosphorous detector (above 1 Mev).

Relative values of fast neutron flux were measured by irradiating phosphorous threshold detectors (above 1 Mev) and counting β-activity of the foils as described in an earlier paper (*2*). These foils were 2.5 cm × 2.5 cm in area

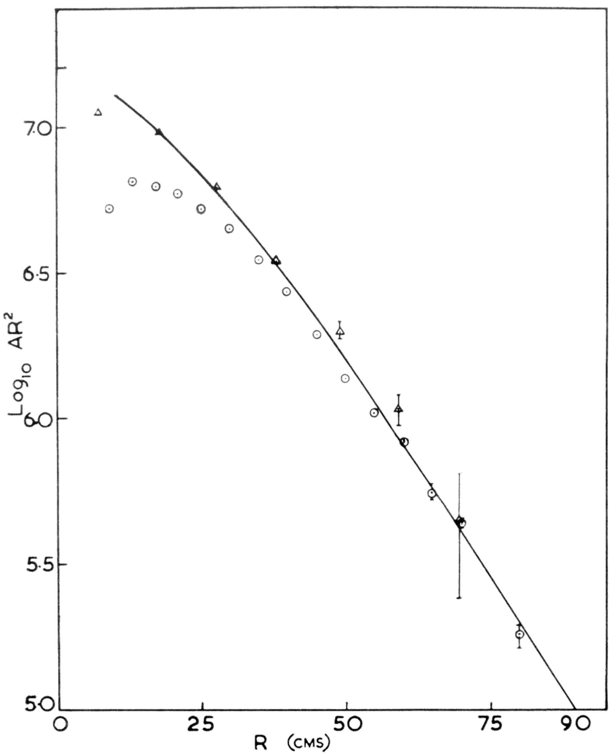

FIG. 3. Log AR^2 (in arbitrary units) as a function of distance R (in cm) in pure water. △ Phosphorous detector (above 1 Mev). ○ Indium detector (1.46 ev). — Theoretical curve for phosphorous detector using the Goldstein *et al.* calculations.

and 3 mm thick. Indium detectors, used to detect resonance neutron flux (1.46 ev), were of the same cross-section area and 0.12 mm thick.

The saturation activity A of the foils was measured as a function of distance R taken from the center of the target tube. Figure 2 shows curves of log AR^2 (relative values) as a function of distance R obtained with In and P detectors in 6-in. Pb + H_2O medium. It is seen that more than 60 cm from the source, the rate of attenuation of the two curves is about the same. This is in agreement with the theoretical predictions (*3*) that at large distances from the source, flux at all energies will fall off, apart from a geometrical factor, as $\exp(-N\sigma_{tr}R)$, where $N\sigma_{tr}$ is the macroscopic transport cross section and E is the source energy. Assuming the neutron flux to fall off as $[\exp(-R/L)]/R^2$, the value of relaxation length L between 60 and 70 cm was found to be 13.6 ± 0.5 cm. Figure 3 shows similar curves in the case of pure water. As in Fig. 2, at large distances the rate of attenuation of P and In curves is about the same. The solid curve in Fig. 3 represents the expected theoretical response of a P detector based on the results of Goldstein *et al.* (*4*). In their treatment, using the moments method to solve the Boltzmann equation, the energy spectrum of neutrons as a function of distance has been obtained from a 14.03 Mev source in water. The cross-section curve for the $P^{31}(n,p)Si^{31}$ reaction (*5*) as a function of energy was integrated over the theoretical curve at different distances. The curve thus obtained represents the expected theoretical response of a P detector from a 14.03 Mev source in water. The experimental points have been normalized with the theoretical curve at 17.5 cm. It is seen that experimental points higher than 45 cm lie above the theoretical curve. This has also been observed in the dose measurements by Caswell *et al.* (*1*). The accuracy of the theoretical calculations is estimated by the authors as 15%. There is an inaccuracy of about 8% in the determination of $P^{31}(n,p)Si^{31}$ cross section and the values between 10 Mev and 14 Mev have not been measured. For the present calculation the cross-section curve was joined smoothly between 10 Mev and 14 Mev. It was also noticed that a variation of 10% in the cross section in this region caused a negligible change in the slope of the theoretical curve. Between 60 and 70 cm, the relaxation length L of the theoretical curve was found to be 15 cm. An uncertainty of about 2 cm in the determination of the exact center of the target was present in all the measurements. No correction has been made for the change in flux caused by the presence of the aluminum tube (3.8 cm diameter) used to bring in the deuteron beam.

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The Inertia Transient in Reactor Draining

In analyzing the problem of reactor draining, or of tank draining in general, three types of transients may be taken into consideration. The most rapid of these transients, which includes inertia and compressibility effects, is the sonic transient. An intermediate transient is obtained by disregarding compressibility and taking into account only the inertia of the fluid, and is termed here the inertia transient. The slowest of the transients results from disregarding both compressibility and inertia effects and assuming that the rate of discharge is governed only by the prevailing head. It is designated as terminal flow, since it characterizes the terminal phase of the inertia transient.

The order of magnitude of time involved in reactor draining problems, arising from reactor control or reactor safety studies, requires that cognizance be taken of the inertia transient. The results presented here have application in the design of reactor control, or reactor scramming systems