# RADIOACTIVITY OF THE COOLING WATER

E. P. Wigner

1. If the water contains p parts per million of an element with an atomic weight m and slow neutron cross section $\sigma$, this substance will absorb about the fraction

$$f = \frac{pV\sigma L \times 10^{-6}}{m\Sigma} = \frac{10^{24}\sigma p}{m} \times .425 \times 10^{-6} \qquad (1)$$

of all neutrons. In the above, $L = 6 \times 10^{23}$ is Loschmidt's number, $V = 3 \times 10^{6} cm^{3}$ is the total volume of the water in the pile and $\Sigma$ is the total cross section of all materials (U, C, etc) in the pile. For a 200 ton U pile $\Sigma \approx 4.25 \times 10^{6} cm^{2}$. Since, in a 500,000 kw pile, $3.5 \times 10^{19}$ neutrons are absorbed per second, the number of new nuclei formed by neutron absorption of the element in question becomes

$$N = 3.5 \times 10^{19} f = \frac{10^{24}\sigma p}{m} \times 1.5 \times 10^{13} sec^{-1} \qquad (1a)$$

The nuclei thus formed by neutron absorption may or may not be radioactive. If, in the former case, the radioactivity is connected with the emission of $\gamma$-rays, it may present a hazard to the personnel at the water exit end of the pile. This hazard is, of course, removed if the pile is shut down as soon as the water which has been in the pile during operation has left the system but is present as far as the personnel inspecting the water outlet system during operation is concerned. In addition, the radioactivity of the cooling water--from the above and other sources to be discussed below--may make it necessary to shield the outlet pipes etc., for some distance.

The $\beta$ radiation will present little actual danger. More probably, it may render it difficult to detect failures in the U sheathing or coating.