PHYSICS GROUP V

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from here NLC to P 13

Metal Testing

Calibration - $\frac{\Delta k}{\Delta ih}$

The critical positions of the control rod were determined with and without 29.7 grams of iron wire wrapped around each of the 16 eggs in Lot #1. The results of the measurements follow:

No iron	Critical position	126.29 ih
With iron	" "	121.80
	Δih due to iron poisoning	4.49 ih

The percent change in reproduction factor per cell caused by the introduction of the iron poisoning can be calculated from the following formula:

$$\Delta k\% = 100 \frac{a}{b} D \times f \times \frac{W_i}{W_u}$$

where $\frac{a}{b}$ is the ratio of neutron density at the surface of the metal lump (where the iron was placed) to the average neutron density inside the lumps; D is the danger coefficient of iron, f is the thermal utilization of the cell, W_i is the average weight of iron per cell, and W_u the average weight of the uranium per cell.

The ratio $\frac{a}{b}$ can be calculated for an equivalent spherical lump (radius = 2.94 cm) assuming a neutron density variation inside the lump of the form:

$$\frac{\sinh \mathcal{K} r}{r}$$

The ratio $\frac{a}{b}$ is then given by the following expression:

$$\frac{a}{b} = \frac{3/R^3 \int_0^R \sinh(\mathcal{K} r)\,dr}{\frac{\sinh(\mathcal{K} r)}{R}} = \frac{(\mathcal{K}R)^2 \sinh(\mathcal{K}R)}{3\left[\mathcal{K}R \cosh(\mathcal{K}R) - \sinh(\mathcal{K}R)\right]}$$

Using Mr. Wigner's value of $\mathcal{K}$ for metal of density 18.8 gms/cm^3

$$\mathcal{K} = .0424 \times 18.8 = .796$$

and with R = 2.94 cm

We obtain $\frac{a}{b} = 1.32$

with D = 1.32 from measurements with CP #1

f = .83

W_i = 29.7

W_u = 1987