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Date 12-14-45

Subject Effect of Stainless Steel Thimbles on

File reactivity.....

To Jordan

From 1st Marshall

Copy No. 3-A

C. F. Kidder

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C. P. Kidder 1-21-46
 G. M. Whitlock 27 Nov 48
 J. E. Plummer 7-31-50
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DECEMBER 14, 1945

TNX Division

THIS DOCUMENT CONTAINS NO SECRECY

TO: W. E. JORDAN

FROM: L. W. MARSHALL

EFFECT OF STAINLESS STEEL THIMBLES ON PILE REACTIVITY

SUMMARY

Failure of a vertical safety rod thimble at 105-B has led to consideration of a stainless steel thimble as a replacement. Such a replacement by 1/16 inch stainless steel would result in a 4% loss in control power of that safety rod. If all thimbles were replaced by 1/16 inch stainless steel there would be a reactivity loss of 790 ih.

Discussion

A. The loss in control power is calculated as follows:

Composition of 18-8 Duralay				
% by Weight	Element	Atomic Weight	Thermal Neutron Cross Section per Atom	Gram-atoms in 25.5 grams
73	Fe	55.8	$2.5 \times 10^{-24} \text{ cm}^2$	0.73
18	Cr	52.0	3.0	0.19
9	Ni	58.7	4.4	0.088

average cross section = $2.77 \times 10^{-24} \text{ cm}^2$ Ave. atomic wt. = 55.5

Fraction of neutrons which penetrate steel thimble =

$\text{cm}^3 \text{ (~7.9 gm/cm}^3 \text{ density} \times (1/55.5) \text{ gm-atom per gram} \times 0.602 \times 10^{24} \text{ atoms per gram-atom}$
 $\times 0.199 \text{ cm wall thickness} \times 2.77 \times 10^{-24} \text{ cm}^2 \text{ cross section per atom)} = 0.943$

hence 4% of the safety rod control power is lost.

B. Reactivity loss due to replacement of an aluminum thimble by a steel thimble is calculated using figures indicated by an asterisk, which have

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been taken from Wheeler to Babcock, October 22, 1943.

Reactivity loss due to an aluminum thimble in a position of average neutron flux

* 0.8 ih

Ratio of thermal cross sections of steel to aluminum

2.77/0.24

Ratio of densities of steel to aluminum

7.9/2.7

Ratio of atomic weights of aluminum to steel

27/55.5

Product of last 4 quantities, the loss due to a steel thimble in a position of average flux

13.2 ih

Loss due to a steel thimble at the center

52.8 ih

Loss due to an aluminum thimble at the center

3.2 ih

Loss sustained when a central aluminum thimble is replaced by steel (difference of above)

49.6 ih

Loss if all thimbles are steel = 63.7×13.2

841 ih

Loss if all thimbles are aluminum = 63.7×0.8

51 ih

Loss if all aluminum thimbles are replaced by steel (difference of above)

790 ih

LWM:NP

L. W. Marshall
L. W. MARSHALL per Wende
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END

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1 / 7 / 93