LETTERS TO THE EDITOR

Greuling-Goertzel Approximation in Muft IV Code

In an article by Levine *et al.* (*1*) in the January issue of Nuclear Science and Engineering, the authors discuss modifications intended to incorporate the Greuling-Goertzel approximation into MUFT. It should be noted that two versions of MUFT have been distributed and can be obtained through IBM. The earlier version, MUFT III (*2*), was designed for the IBM-650; later MUFT IV (*3*) was written for the IBM-704. A simplified form of the Greuling-Goertzel equations is coded into MUFT IV, and this approximation may be selected (as an alternative to age theory) through an input option. If the Greuling-Goertzel option is to be used, appropriate values of the parameter γ (see reference 1) must be added to the MUFT IV library tape. MUFT IV D_2O calculations are described in a letter to the editor of this journal, written by W. H. Arnold (*4*).

In addition, the full Greuling-Goertzel treatment of nonhydrogenous moderation is available in P1MG (*5*), a multigroup space-energy code for the IBM-704. P1MG may be used either to compute the flux in a multiregion reactor, or the flux spectrum for a given buckling, in a *P*-1 approximation.

REFERENCES

1. M. M. LEVINE, K. E. ROACH, D. B. WEHMEYER, AND P. F. ZWEIFEL, The slowing down of neutrons by deuterium. *Nuclear Sci. and Eng.* **7**, 14–20 (1960).

2. R. L. HELLENS, R. W. LONG, AND B. H. MOUNT, Multigroup Fourier transform calculation—description of MUFT-III code. WAPD-TM-4 (July, 1956).

3. H. BOHL, JR., E. GELBARD, AND G. RYAN, MUFT-4—fast neutron spectrum code for the IBM-704. WAPD-TM-72 (July, 1957).

4. W. H. ARNOLD, JR., Age in D_2O–H_2O mixtures. *Nuclear Sci. and Eng.* **6,** 456–457 (1959).

5. H. BOHL, JR., E. GELBARD, G. R. CULPEPPER, AND P. F. BUERGER, P1MG—a one-dimensional multigroup *P*-1 code for the IBM-704. WAPD-TM-135 (July, 1959).

E. M. GELBARD

*Bettis Atomic Power Laboratory**
Westinghouse Electric Corporation
Pittsburgh, Pennsylvania

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Age of U^{233} Fission Neutrons in Water

Recent calculations by Faber and Zweifel (*1*) based on the measured U^{233} fission spectrum indicate that the age of fission neutrons is somewhat smaller for U^{233} than for U^{235}. The practical importance of this result for the interpretation of recent measurements of η of U^{233} and other critical experiments has led to the experimental investigation reported here.

Because of the possible systematic errors associated with an absolute neutron age measurement in water a relative measurement procedure was adopted here in which the second moments of the indium resonance activation flux from small converter disks of U^{233} and U^{235} were compared under identical experimental conditions. The measurements were carried out in a 4 × 4 × 5 ft water tank with the converter disks located at the end of a $2\frac{1}{8}$-in. o.d. aluminum re-entrant tube. The converter disks were excited by a collimated thermal neutron beam from the 8-in. beam port of the Lynchburg Pool Reactor. The fission sources were of 25 g U^{233} and 24 g U^{235} in the form of uranyl nitrate and held in a stainless steel container of approximately $1\frac{5}{8}$-in. i.d. Background runs were made with the stainless steel holder in place and the fission source replaced by a mock absorber and scatterer made of 19.7 g Dy_2O_3 mixed with 7.3 g powdered polyethelene. The detector foils were of $\frac{1}{4}$- and $\frac{1}{2}$-in. diameter indium of 96 mg/cm² thickness held in cadmium boxes and mounted on a Lucite rack on the axis of the source disk.

Three runs with the U^{233} source were made and analyzed separately. These gave experimental ages of 27.7 ± 1.0, 28.4 ± 1.1, and 26.6 ± 1.1 cm² from which a weighted average of 27.6 ± 0.6 cm² was calculated. Two runs with U^{235} were made and the results of these were 28.8 ± 1.0 and 29.7 ± 1.3 cm² which gave a weighted average of 29.1 ± 0.8 cm². In view of the possible perturbation caused by the fission sources, the source holder, and the re-entrant duct, these results should not be taken for their absolute value. Considered relatively, however, they should be as reliable as the given statistical errors imply. The age of U^{233} neutrons thus appears to be less than that of U^{235} neutrons by (5 ± 3)%. This is in agreement with the calculations of reference (*1*).

REFERENCE

1. M. FABER AND P. F. ZWEIFEL, *Nuclear Sci. and Eng.* **6,** 81 (1959).

W. G. PETTUS

The Babcock and Wilcox Company
Atomic Energy Division
Lynchburg, Virginia

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