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A Coupled Neutron and Gamma Ray Multigroup
Cross Section Library for Use in Shielding Calculations*

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* Operated by Union Carbide Corporation, Nuclear Division for the U. S. Atomic Energy Commission.

A state of the art library of coupled neutron and gamma ray cross sections has been compiled for several elements that are commonly used for shielding calculations. The coupled cross sections have been expanded in a P_3 Legendre expansion and are given in the ANISN format which permits their usage in the discrete ordinates codes ANISN¹ and DOT² as well as the three dimensional Monte Carlo code, MORSE.³ A list of the nuclides that are present in the library is given in Table I.

The source for the neutron cross sections was the ENDF/B-II library. The SUPERTOG⁴ code was used to generate resonance corrected fine group cross sections for 104 energy groups⁵ from the ENDF/B library. Single level Breit-Wigner or multi-level Breit-Wigner resonance parameters were used by SUPERTOG to generate point cross sections for the resonance nuclides. Approximately 100 points per resolved resonance were used to integrate the point cross sections for the fine groups. In the unresolved resonance region 81 points per fine group were used for the integration. A $1/E$ spectral weighting function was used.

The multigroup neutron cross sections in a 22 energy group structure were obtained from the 104 group cross sections by averaging the various elemental cross sections across a fine group flux calculated by ANISN for a uranium-water mixture using fine group cross sections.

The secondary gamma-ray production cross sections were calculated by the POPOP⁶ code. Gamma-ray transport cross sections were calculated for an 18 group gamma energy structure by the MUG⁷ code. The multigroup neutron cross sections, the secondary gamma production cross sections, and the gamma ray transport cross sections were coupled to form a 40 group set. This is the same 40 group structure as used by Straker for various shielding calculations.⁸

Calculations of the neutron and gamma ray fluence from several shielding problems have been performed using this library.⁹ The results of these calculations will be discussed.

References

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4. R. Q. Wright, et al., "SUPERTOG: A Program to Generate Fine Group Constants and P_n Scattering Matrices from ENDF/B," ORNL-TM-2679, (1969).
5. A. E. Profio, Ed., "Shielding Benchmark Problems," ORNL-RSIC-25, (1970).
6. W. E. Ford, III and D. H. Wallace, "POPOP⁴ A Code for Converting Gamma-Ray Spectra to Secondary Gamma-Ray Production Cross Sections," CTC-12, (1969).
7. J. R. Knight and F. R. Mynatt, "MUG - A Program for Generating Multigroup Photon Cross Sections," CTC-17, (1970).
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Table I

22-18 Library of Coupled Neutron and Gamma Ray Cross Sections

<u>Element</u>	<u>ENDF/B MAT</u>	<u>POPOP4 ID</u>
H	1001	010101
Be	1007	040101, 040401
B-10	1009	050201
C	1040	060102, 060301
N	4133	070102, 070301
O	1013	086301, 080201
Na	1059	110101, 113301
Mg	1014	120101, 120301
Al	1015	130101, 130301
Si	530	140101, 140301
K	5005	190101, 190301
Ca	540	200101, 200301
Ti	1016	220101, 220301
Cr	1121	240101, 240301
Mn	1019	250101
Fe	1124	260110, 260301
Ni	1123	280101, 280301
Cu	1087	290101
Mg	1111	420101
Ta	1060-1063	740107
W	1126	731303, 731107
Pb	43	820102, 820301
U-235	102	925101, 925301, 925801
U-238	103	928112, 925301, 925801
Pu-239	104	928112, 925301, 925801
Pu-240	105	928112, 925301, 925801