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VITAMIN-E 174N,38G GENERAL PURPOSE CROSS-SECTION LIBRARY

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ABSTRACT VITAMIN-E, offering a different approach to obtaining multigroup cross sections for a wide range of radiation transport analyses, is now available from RSIC.

INTRODUCTIONBackground Information About the VITAMIN Concept

The "VITAMIN" concept is a different approach to obtaining appropriate cross sections for radiation transport analysis. It allows the user access to a fine-group data base from which application-dependent libraries can be derived. Temperature and resonance self-shielding correction can be made through the Bondarenko self-shielding factor method.¹ The VITAMIN concept extends this "table-look up" approach to a wider range of radiation transport problems by utilizing many energy groups and by accommodating photon production and transport. The concept offers a flexible alternative to the difficult and expensive task of generating a new data library from ENDF/B for each application or using an inflexible cross section set (perhaps designed for an entirely different application).

Success of the VITAMIN Concept

The effort to produce a general-purpose fine-group cross-section library based on ENDF/B-V was undertaken because of the success of VITAMIN-C.² Based on ENDF/B-IV, the VITAMIN-C library has been applied to a wide variety of neutron and photon transport problems. These included fusion neutronics, fast-reactor shielding and physics calculations, light-water reactor shielding and pressure-vessel dosimetry applications, shipping-cask design, shielding benchmarks and air-transport analyses.

Development of a VITAMIN Library Based on ENDF/B-V

In anticipation of the release of a new major version of ENDF/B, comments on desired characteristics of a successor to VITAMIN-C were solicited. The results are summarized in Ref. 3, the new version being designated VITAMIN-E.

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SPECIFICATIONS OF THE INITIAL RELEASE OF VITAMIN-E

The acronym VITAMIN is derived from the phrase Versatile Integrated Techniques using AMPX and MINX for Investigating Neutronics. The designation "E" (the fifth letter of the alphabet) represents the alphabetic equivalent of the fifth version of ENDF/B, the primary source of evaluated data used to produce VITAMIN-E.

Sources of Evaluated Data

As indicated above, the primary source of evaluated neutron and photon production data for VITAMIN-E is ENDF/B-V.⁴ Additional materials were obtained by processing the Lawrence Livermore National Laboratory (LLNL) evaluated data library LENDL.⁵ The LENDL data were used if a desired evaluation was not available from ENDF/B or, in some cases, if the ENDF/B evaluation was incomplete (e.g., no photon production data).

The photon interaction data used for VITAMIN-E are a recent evaluation by Hubbell⁶ that has been packaged in RSIC as DLC-99/HUGO⁷ and will be released as the ENDF/B-V photon interaction evaluated data.

Contents of VITAMIN-E

Two types of neutron multigroup data are provided; (1) data for transport calculations and, (2) neutron reaction cross sections. Data sets for transport calculations, 77 in number, are derived primarily from the ENDF/B-V General Purpose File. Of these, 56 data sets have both neutron and secondary photon production. Photon interaction transport cross sections with P_0 scattering matrices are provided for all elements in the Z-range of 1 to 100.

Energy Group Structure

The energy group structure is a slight refinement of that used for VITAMIN-C. The (174n,38g) (VITAMIN-C has 171n,36g) group structures allowed for the formal inclusion of the group boundaries of the Defense Nuclear Agency few-group library DLC-31/FEWG1.⁸

Weighting Functions

The functional form of the neutron and photon-production weighting function is Maxwellian, 1/E, fission, 1/E, fusion peak and 1/E. For photon interactions, it is assumed constant in energy.

Processing Codes

The neutron transport cross section and Bondarenko factor processing was done using the MINXI5^{9,10} system. Photon production and transport cross section processing was done using the LAFHNGAS and SMUG modules of AMPX.¹¹ This combination was

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chosen again because of its successful performance in the generation of VITAMIN-C, the experience obtained by ORNL and General Electric as part of the preliminary ENDF/B-V Data Testing, and the improvements to the modules as described in Ref. 12.

Output Formats

The initial release of VITAMIN-E is in AMPX format (as was DLC-41/VITAMIN-C). It is expected that later releases will be provided in CCCC and MATXS formats.

AVAILABILITY OF VITAMIN-E

RSIC Data Library Package DLC-113/VITAMIN-E

The initial release of the library in AMPX format is called DLC-113/VITAMIN-E which is available from RSIC.

As with VITAMIN-C, VITAMIN-E is designed to be used in conjunction with the PSR-63/AMPX-II or PSR-117/MARS packages, which are also available from RSIC.

VITAMIN-E on the NMFECC

A selected portion of the VITAMIN-E materials has been placed on the National Magnetic Fusion Energy Computing Center (NMFECC) at Lawrence Livermore National Laboratory in formats directly useable in discrete ordinates codes. In the future, versions of VITAMIN-E in AMPX and MATXS formats will be placed on NMFECC.

APPLICATIONS OF VITAMIN-E

During the development stages and prior to the general release of VITAMIN-E from RSIC, the data have been used in a wide range of applications. The experience gained through these exercises has provided confidence in the performance of the library. It has been used for CSEWG fast reactor data testing, to produce the DNA few-group cross-section library, to participate in the NEACRP fast reactor benchmark exercise, to analyze the fusion integral experiment analysis, to study fusion/fission hybrid designs, to analyze accelerator breeder concepts, to assess fusion neutronics data needs, to facilitate the fusion blanket comparison selection study, and to develop light-water reactor dosimetry methodology.

FUTURE PLANS FOR ADDITIONS TO VITAMIN-E

The VITAMIN-E data library is maintained and updated at RSIC. Feedback on its use is very important, and users are urged to contact RSIC about problems and suggestions. New evaluations or revisions to ENDF/B-V which are of interest in the application areas of VITAMIN-E will be processed as needs arise.

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