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TITLE ENDF/B-VI SIX-GROUP DELAYED NEUTRON DATA

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ENDF/B-VI SIX-GROUP DELAYED NEUTRON DATA

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In addition to individual precursor data [emission probabilities (Pn) and neutron spectra], the ENDF system requires $\bar{\nu}(E)$, and its time-dependence and spectra using a few time groups. These data have been greatly extended, tested, and recently (June 1989) compared with new measurements of pulse spectra.

Temporal group data can be obtained from aggregate measurements, as has been the practice in earlier versions of ENDF,[1] or from summation calculations using precursor data [emission probabilities (Pn), spectra, halflives, branchings, and fission product yields]. Until recently the precursor data were not sufficiently complete for the latter approach. Measurements were limited to a few fissionable nuclides and even more limited in the range of measured aggregate spectra.

We now have a complete set of data for 271 precursors. It includes all known Pn and spectral measurements, supplemented with model calculations, in 10-keV bins from 0-~10 MeV. Most, or all of these data will be included in the radioactive sub-libraries.

For 28 fissioning nuclides we have calculated the aggregate time-dependence and approximated this with six temporal groups (abundances, halflives and consistent group spectra). The group spectra are in 10-keV bins extending from 0-3 MeV. [ENDF/B-V used 28 bins from ~ 70 to 1.2 MeV. Such data were available for only six fissioning nuclides; it was assumed that the group spectra for time Group 6 (and usually Group 5) was the same as Group 4]

This precursor work has extended over several years and is well documented in several publications; the most recent and comprehensive sources are Refs. 2-5. References 4 and 5 include the results of all data testing except for the ^{239}Pu and ^{238}U spectral comparisons in this paper.

Having a fiducial data base permits an answer to some existing questions (discussed in the earlier references):

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(a) Six-groups are an adequate representation; nine would be better, but unnecessary for most applications; more than nine-groups is not likely to be needed in applications.

(b) There is very weak spectral dependence on the energy of the incident fission neutron; this is fortunate because ENDF/B formats permit only such dependence on $\bar{\nu}_d$ (the lack of dependence is confirmed by the recent experiments[2,6-7]).

We do not expect the new data will produce significant changes in most types of reactor calculations, but we have already used the data in other problems where its difference from ENDF/B-V appears very significant. The difference in energy range has been confirmed by recent, unpublished Los Alamos measurements. Figure 1 compares group spectra for ^{235}U fission over 0-1 MeV between ENDF/B-V and -VI.

The University of Lowell has recently completed time-of-flight spectra measurements for delayed neutrons from ^{235}U, ^{239}Pu, and ^{238}U fission pulses.[2,6-7] Comparisons with their ^{235}U data and the new group data in ENDF/B-VI have been made.[5] Their ^{239}Pu and ^{238}U measurements were made available for this report in June 1989. Comparisons for all three fuels are shown in Fig. 2 at three decay intervals. These are total spectra (ENDF/B-VI group values are summed) following decay from a fission pulse. Data generally agree within measured uncertainties. The largest uncertainty in measurements are the ^{239}Pu values (100-50% at small energies). We are currently trying to understand the differences that do exist but the agreement is generally very good, particularly for pulse spectra.

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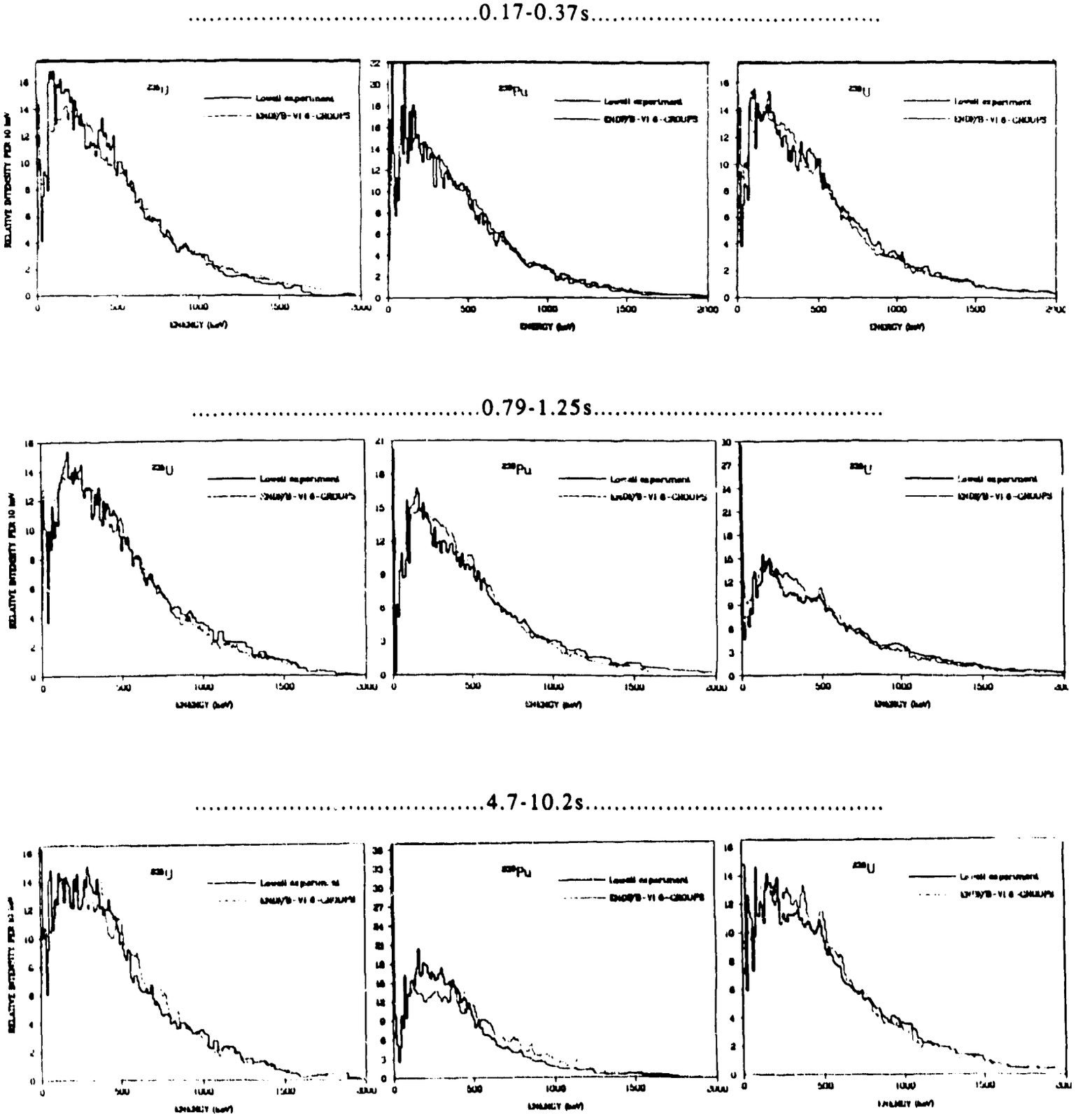

Fig. 2. Pulse spectra comparisons with Lowell measurements.

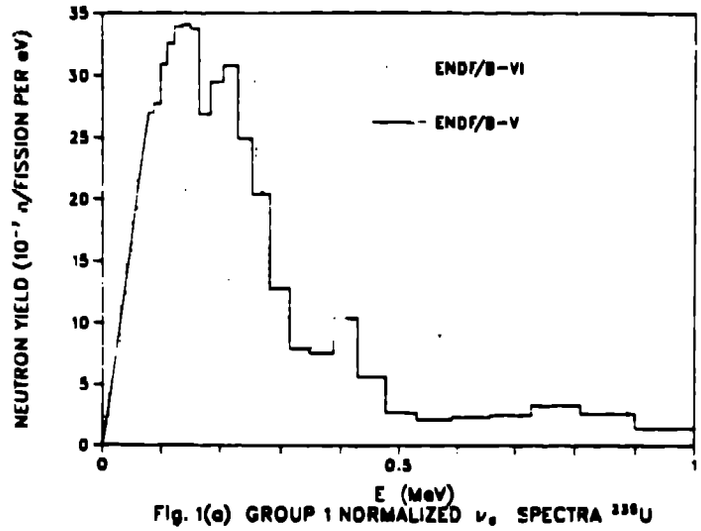

Fig. 1(a) GROUP 1 NORMALIZED ν_d SPECTRA ^{238}U

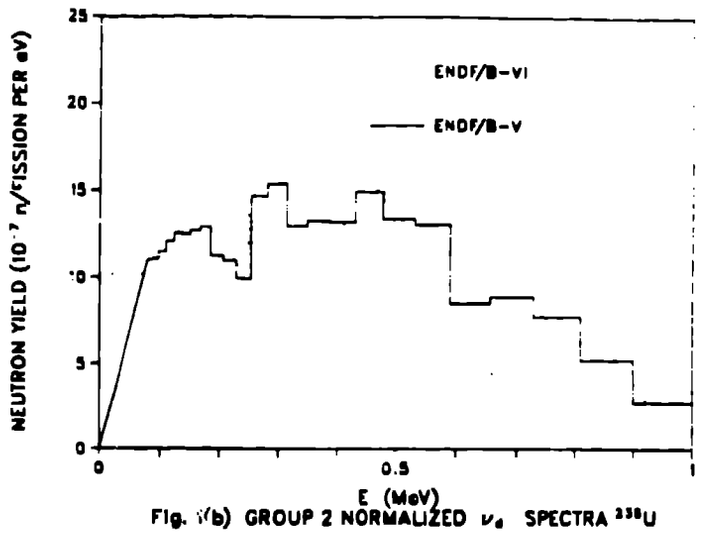

Fig. 1(b) GROUP 2 NORMALIZED ν_d SPECTRA ^{238}U

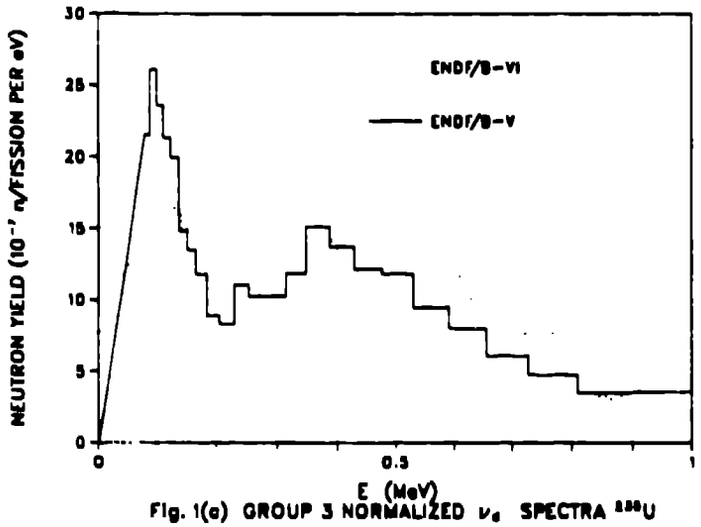

Fig. 1(c) GROUP 3 NORMALIZED ν_d SPECTRA ^{238}U

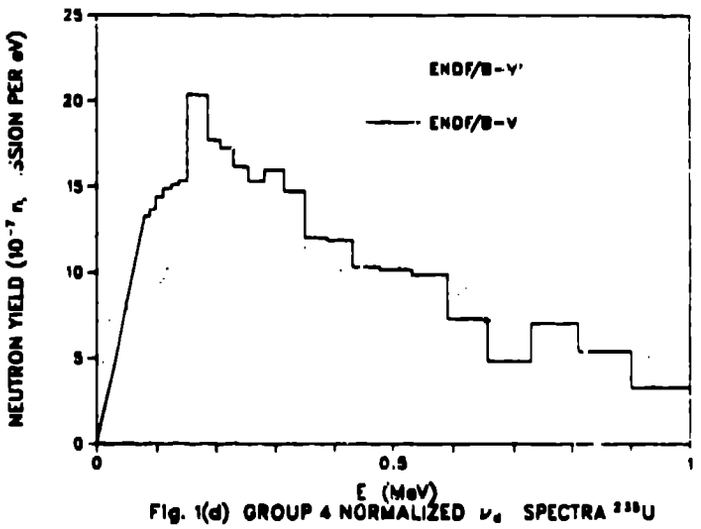

Fig. 1(d) GROUP 4 NORMALIZED ν_d SPECTRA ^{238}U

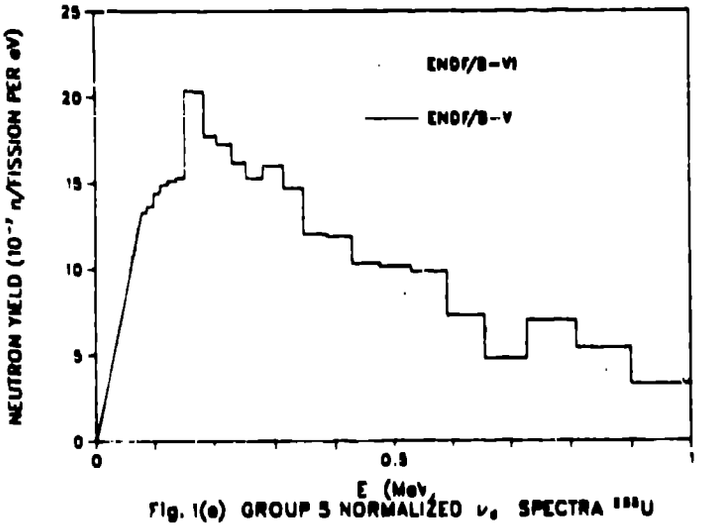

Fig. 1(e) GROUP 5 NORMALIZED ν_d SPECTRA ^{238}U

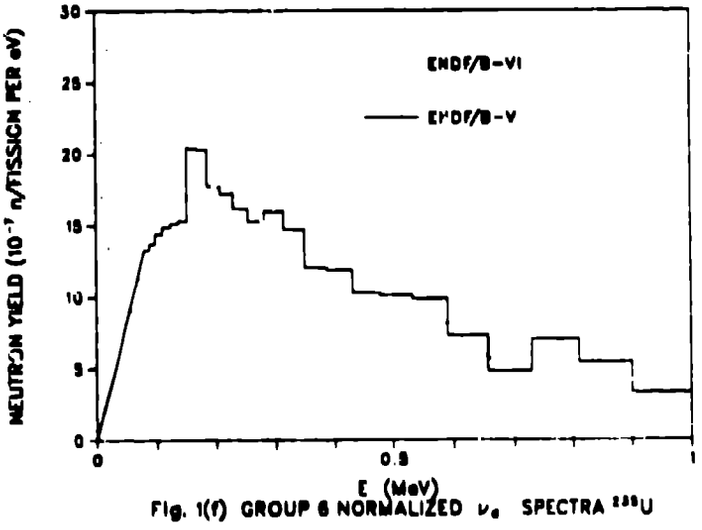

Fig. 1(f) GROUP 6 NORMALIZED ν_d SPECTRA ^{238}U

Fig. 1. Comparison of ENDF/B-V ON ENDF/B-VI group spectra.