PROCESSING AND TESTING THE ENDF/B-VI

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Since the release of the ENDF/B-VI nuclear data file by the IAEA to the nuclear community there has been a great deal of interest to access this file and also to evaluate to impact of this new data file in the analyses of the benchmark experiments.The ENDF/B-VI brought with an increased scope of nuclear data such as data for the Fe, Ni, Cr isotopes, new representation (Reich-Moore Formalism) and also extended range in the resolved resonance region for the main actinides, and new representation (double differential cross sections) for the energy-angle distribuition for the particle emission spectrum in the fast neutron energy region. However, at the same time, the ENDF/B-VI brought with new complications since at the time of the release most of the pre-processing codes were not able to access this file.

The purposes of this work are twofold : first, to show the ENDF/B-VI processing procedure developed at IPEN/CNEN-SP and second, to test the ENDF/B-VI nuclear data against several well-known CSEWG benchmark problems[1] .

The ENDF/B-VI processing methodology starts with the Cullen's codes LINEAR[2],RECE N T[3] and SIGMA-1[4] version 89.0 to make the linearization, resonance reconstruction and Doppler-Broadening (293 K) respectively . All nuclides used in this paper but U-238

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have been processed with 0.5% for linearization and 0.2% for Doppler Broadening; U-238 has been processed with 0.5% for both linearization and Doppler-Broadening due to the extremely high processing time. Next, it was made use of the GROUPXS code [5] to handle the double-differential cross sections. Here, the double differential cross section is converted into the usual MF4 + MF5 formalism in the laboratory system. One example is given with the multigroup scattering matrices calculated by GROUPXS using directly the data on MF6. In order to compatibilize the MF6 of ENDF/B-VI and GROUPXS and ENDF/B-VI an ENDF/B-VI pre-processor (LINKOA)[6] was written. LINKOA changes simultaneously from LEP=1 (Histogram Interpolation Scheme) to LEP=2 (Linear-Linear Interpolation Schemes) for LANG=1 or LANG=2, from KALBACH-MANN Systematics (LANG=2) to Legendre coefficients (LANG=1) with NA=6 and other minor adaptations. Multigroup libraries have been generated by NJOY (version 10/83) by using the output of GROUPXS and transformed into the MASTER library of AMPX-II[7] by using an in house interface program AMPXR . The Keff and spectral indices analyses have been performed by XSDRNPM. The final results are shown in the Tables 1 and 2.

According to Tables 1 and 2 the following conclusions can be drawn : a) The processing methodology of this work shows overall results in a good agreement b) There appears to be a systematic underestimation of the Pu-239 fission reaction rates as pointed out in Table-2 with a clear effect on the Keff of JEZEBEL c) The effect of the scattering matrices calculated directly on the data on MF6 does not appear to be important compared to that on the usual way (MF4 + MF5). d) The long-standing problem of the Keff overprediction in well moderated plutonium systems (PNL) still remains e) The trend toward increased leakage[8] for the ORNL experiments still remains in ENDF/B-VI f) The slightly lower values of Keff of ENDF/B-VI for ORNL compared to that of ENDF/B-V may be credited mostly to the lower value of νth of U-235 of ENDF/B-VI. It is recommended further analyses for Th-232 and U-233 fast cross sections. It is hoped that the results shown in this work be helpfull for the CSEWG and the evaluators of ENDF/B-VI.

References

[1] Cross Section Evaluation Working Group Benchmark Specification; ENDF-202 (BNL-19302).

[2] Cullen D. E. ; "Program LINEAR : Linearize data in the evaluated nuclear data file/version B (ENDF/B) format"; UCRL-50400 (LANL).

[3] Cullen D. E. ; "Program RECENT : Reconstruction of energy dependent neutron cross-sections from resonance parameters in the ENDF/B format"; UCRL-50400 (LANL).

[4] Cullen D. E. ; "Program SIGMA1 : Doppler broaden evaluated cross-sections in the evaluated nuclear data file/version B (ENDF/B) Format"; UCRL-50400 (LANL).

[5] Gruppelaar H. et al.; Processing of Double Differential Cross Sections in the New ENDF/B-VI Format : GROUPXS Code Description and User's Manual ; ECN-182 or NEA-1111/01 - April 1986.

[6] Caldeira A. D. ; Instituto de Estudos Avançados CTA - Sao Jose dos Campos - Brazil ; Personnal Communications

[7] Greene N. M.; Ford III W. E. at alli : "AMPX-II : A modular code system for generating coupled multigroup neutron-gamma libraries from data in ENDF format "; PSR-63 Oak Ridge National Laboratory.

[8] Prael R. E.; Homogeneous Thermal Benchmark Calculations with ENDF/B-V Data Using MCNP - Trans. Am. Nuc. Soc. Vol. 35 November 1980.

Table 1 : Calculated and Experimental Keff

Benchmark	K - Effective		
	Calculated	ENDF/B-V [c]	Experimental
JEZEBEL[a]	0.99735	-------	1.000 ± 0.003
JEZEBEL[d]	0.99701	-------	1.000 ± 0.003
GODIVA[a]	0.99897	-------	1.000 ± 0.003
PNL-1[b]	1.01674	1.0211	1.00000
PNL-2[b]	1.00850	-------	1.00000
PNL-3[b]	0.99708	1.0003	1.00000
PNL-4[b]	1.00510	1.0072	1.00000
PNL-5[b]	1.01001	1.0110	1.00000
ORNL-1[b]	1.00228	1.0025	1.00026
ORNL-2[b]	1.00186	1.0020	0.99975
ORNL-3[b]	0.99897	0.9972	0.99994
ORNL-4[b]	1.00061	1.0016	0.99924

a : 171 groups, VITAMIN-C structure

b : 85 groups, 36 Thermal groups, thermal energy cutoff (1.855 eV), thermal scattering data for Hidrogen from ENDF/B-III.

c : from reference [6]

d : multigroup MF6 scattering matrices by GROUPXS

Table 2 : Sectral Indices at Core Center

Indices	GODIVA		JEZEBEL	
	Calculated	Exp.	Calculated	Exp.
σ_f(U-238)/σ_f(U-235)	0.1598	0.156 ± 0.005	0.2093	0.205 ± 0.008
σ_f(Pu-239)/σ_f(U-235)	1.3829	1.42 ± 0.02	1.4266	1.49 ± 0.03
σ_f(U-233)/σ_f(U-235)	1.5918	1.63 ± 0.10	1.5773	1.61 ± 0.10
σ_f(U-234)/σ_f(U-238)	4.8781	5.0 ± 0.2	-------	--------
$\sigma_{n,\gamma}$(U-238)/σ_f(U-238)	0.4713	0.47 ± 0.02	-------	--------
σ_f(Th-232)/σ_f(U-238)	0.2453	0.234 ± 0.005	-------	--------
σ_f(Np-237)/σ_f(U-235)	--------	---------	0.9592	0.99 ± 0.05