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A report on work done in the frame of JEF activity under the leadership of OECD NEA DATA BANK (BANQUE DE DONNEES DE L'AEN OCDE)

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Abstract

JEF-1 basic evaluation was tested by calculating fast critical experiments using the cross section discrete-ordinates transport code ONEDANT with $P_3 S_{16}$ approximation. In each computation a spherical one dimensional model was used, together with a 174 neutron group VITAMIN-E structured JEF-1 based nuclear data library, generated at EIR with NJOY and TRANSX-CTR. It is found that the JEF-1 evaluation gives accurate results comparable with ENDF/B-V and that eigenvalues agree well within 10 mk whereas reaction rates deviate by up to 10 % from the experiment. U-233 total and fission cross sections seem to be underestimated in the JEF-1 evaluation in the fast energy range between 0.1 and 1 MeV. This confirms previous analysis based on diffusion theory with 71 neutron groups, performed by H. Takano and E. Sartori at NEA Data Bank.

Zusammenfassung

Die JEF-1 Querschnitts-Grundauswertung wurde anhand der Berechnung der schnellen Kritikalitätsexperimente getestet. Das eindimensionale Transportprogramm ONEDANT mit $P_3 S_{16}$ Approximation wurde dabei benützt, zusammen mit einer 174 VITAMIN-E sturkturierten Neutronengruppen-Bibliothek, die aus den JEF-1 Daten am EIR mit NJOY und TRANSX-CTR generiert wurde. Es wird gezeigt, dass die JEF-1 Resultate mit denjenigen aus ENDF/B-V verglichen werden können, dass die Eigenwerte um 10 mk und alle Reaktionsraten um maximal 10 % von den experimentellen Werten abweichen. Der totale und der Spaltquerschnitt von U-233 scheinen in der JEF-1-Auswertung unterschätzt zu werden, insbesondere im Energiebereich zwischen 0.1 und 1 MeV. Dies bestätigt eine vorhergehende Analyse, die mit Diffusionstheorie bei NEA-Data Bank von H. Takano und E. Sartori durchgeführt worden ist.

CONTENTS

1 INTRODUCTION

During the last 10 to 16 years a large effort was invested in improving nuclear data evaluations. Special concern was directed to the improvement of resonance data, high energy cross sections, unresolved resonance parameters, scattering laws of fission products, spherical scattering laws, etc. The last fruit of this effort in Europe is the European JEF-1 file developed under the leadership of NEADB and distributed in April 1985 /1/.

A first task for EIR was the testing of the new JEF-1 data files. For this purpose fast criticality experiments were computed. Up to now computational analyses were undertaken using models based on diffusion theory /2/. Therefore in this analysis all calculations which were performed in spherical geometry were based on the transport theory /3/ together with a NJOY 174 neutron group VITAMIN-E structured JEF-1 data library with small modifications in some energy boundaries. All results were compared with those obtained using ENDF/B-V evaluation /4/,/5/ and with experiment /6/. Data included in this analysis are neutron spectra, multiplication factors, k-eff, reaction rates and spectral indices at core centre. In these investigations all multigroup cross sections were produced with the generation system NJOY /7/ and linked to the nucleonic one dimensional transport code ONEDANT /3/ through the TRANSX-CTR /8/ module.

All calculations were performed using P_3S_{16} approximation. It is found that the JEF-1 evaluation gives accurate results comparable to those from the ENDF/B-V evaluation. It is shown that all eigenvalues agree well within 10 mk with experiment except of U-233 assemblies where larger discrepancies arise. Reaction rates result to be in good agreement within 10 % with experiment, especially for fissionable materials. This confirms previous results obtained using JEF-1 data libraries with fewer neutron groups /2/.

In the next sections, results from the analyses, computational methods and Benchmark specifications including nuclide densities and spherical radii will be summarized. Last chapter gives some recommendations and conclusions.

2 COMPUTATIONAL MODEL AND NUCLEAR DATA

All nuclear data used is based on the JEF-1 cross section files. Energy boundaries utilized in all multigroup transport calculations come primarily from the VITAMIN-E structure, consisting of 174 neutron groups, and are displayed in Table 2-1. This choice was performed according to the fact that VITAMIN-E groups are generally assumed to be very accurate in describing shielding, fusion and fast systems. These cover the full energy range between 10^{-5} eV and 20 MeV. 9 groups are situated in the thermal range below 2.5 eV and most groups (about 60) are distributed in the important MeV range. Iron, oxygen and structural material resonances are taken into account, since many fine groups lie in their energy range. In Table 2-1 are marked those boundaries which deviate slightly from the VITAMIN-E structure. Starting from the JEF-1 ENDF/B-V formatted files, pointwise cross section PENDF files were created, using the NJOY system /7/. These files which are in ENDF/B format, were generated by the modules RECONR, BROADR, UNRESR, HEATR and THERMR. The RECONR module reconstructs pointwise (energy-dependent) cross sections from ENDF/B resonance parameters and interpolation schemes. Resonance cross sections are calculated with an extended version of the methods of RESEND. BROADR Doppler-broadens and thins pointwise cross sections using the method of SIGMA modified for better behaviour at high temperatures and low energies. UNRESR computes effective self-shielded pointwise cross sections in the unresolved-resonance region using the methods of ETOX. HEATR generates pointwise heat production cross sections (kerma factors) and radiation-damage-energy production cross-sections. THERMR produces incoherent inelastic energy-to-energy matrices for free or bound scatters, coherent elastic cross sections for hexagonal materials, and incoherent elastic cross sections. Starting from the JEF-1 files and from the related PENDF data, multigroup cross sections have been processed using the GROUPR module /9/. These cross sections are written onto groupwise files GENDF in ENDF/B format. These files are assumed to be almost problem independent since they are based on a very fine 488/99 neutron/photon group structure /9/, including 130 thermal groups and many fine groups in the resonance energy range of important isotopes as well as in the higher fusion MeV region. Most standard structures are a subset of the 488 energy groups. An adequate weighting spectrum with respect to a broad class of applications was used to collapse point data into multigroup cross sections (option 8 in GROUPR). This is a mixture of thermal, 1/E, fast reactor and fission plus fusion functions. A multigroup approximation of the spectrum is depicted in Fig. 2-1. The GENDF files contain vectors for all reaction types, matrices for reactions producing neutrons, including fission together with mixed data pertaining to fission yields of prompt and delayed neutrons. The thermal energy range was treated according to the free gas model. Upscatter has been considered. For bounded atoms, such as H in H_2O, H in CH_2, coherent and incoherent thermal scattering was included. The files pertaining to isotopes with many important resonances in the resolved energy range such as U-235, U-238, Fe, were obtained by applying the method of the flux calculator to compute shielded cross sections. Using this approach the absorbing nucleus is assumed to be situated in an uniform moderating region. The narrow approximation applies for the moderator, but not for the resonance nuclide, for which the Bondarenko model holds above the resolved range. 4 dilution cross sections, namely 10^{10}, 10^{4}, 100 and 1 barns were considered for such nuclides. For remaining isotopes only the infinitely diluted data were computed. The GENDF data files consist of P_5 cross sections /9/. All GENDF cross sections were then collapsed into the VITAMIN-E groups using the new NJOY module COLLGR /10/, together with the multigroup version of the weight function based on thermal, 1/E, fast reactor and fission + fusion spectra employed previously. This weighting scheme is adequate for fast Benchmark calculations. Only infinitely diluted cross sections at room temperature were collapsed, since the relevant neutron energy is higher than resonances and many fine groups describe resonances of structural materials (see Table 2-1). Some energy boundaries differ slightly from VITAMIN-E (see Table 2-1). This is because these groups could not be represented exactly as a subset of the 488 groups. The single GENDF files were then combined into a single file using the NJOY module ECOMBR. This file was later structured to form a MATXS library /7/ with the NMATXS module, using the subblocking option, to avoid too large a record length. The JEF-1 based MATXS file with VITAMIN-E structure is available for general purposes with respect to fast as well as to fusion and shielding neutronics calculations. The code TRANSX-CTR /8/ was applied to each of the Benchmark specifications to produce infinitely diluted card image multigroup macroscopic cross sections from the MATXS library. Thus, problem dependent XSLIB data files of mixed cross sections in 174 neutron groups suitable for the one-dimensional transport code ONEDANT were created. The use of these problem dependent libraries avoids large computing time in mixing cross sections during the transport calculation. No upscatter groups were considered. Furthermore the Bell-Hansen-Sandmeier transport correction was used to account accurately for the anisotropy. Zone dependent fission spectra data were collapsed from the different fission matrices on the MATXS file using the referenced weight function (see Fig. 2-1) and in some cases utilizing the correct flux distribution from the RTFLUX /11/ basic file from the ONEDANT computation. This allowed an estimate of the importance of the weighting scheme used to collapse χ with the performance of the critical assemblies. These spectra were incorporated into the P_0-P_3 card image tables as a response function. Extra edit card image cross sections were generated separately using TRANSX-CTR and the same MATXS file to avoid large computing time in producing full matrix data of activation isotopes in the transport calculation itself. All transport calculations were performed with the one dimensional discrete-ordinates transport code ONEDANT with P_3S_{16} approximation, using the 174 neutron group VITAMIN-E structured problem related cross section libraries generated with TRANSX-CTR. The internal module CHIVEC was employed to select the spatial dependent fission spectrum from the basic XSLIB multigroup cross sections for preparing the ONEDANT input files. Spectral indices and reaction rates were computed in a separate ONEDANT run using the RTFLUX flux file from the transport calculation and the response card image library described previously.

In the following section all Benchmark specifications including the detailed nucleonic approach (zone definition, meshing, boundary conditions) will be described, together with the results from the different computations.

Table 2-1: Neutron 174 Energy Group Structure in eV for VITAMIN-E *)

Group Number	Group Limit E (Top)	Group Number	Group Limit E (Top)
1	1.964E+07 (1.997E+7)**)	31	4.966E+06
2	1.733E+07	32	4.724E+06
3	1.690E+07	33	4.493E+06
4	1.649E+07	34	4.066E+06
5	1.568E+07	35	3.679E+06
6	1.492E+07	36	3.329E+06
7	1.455E+07 (1.467E+7)	37	3.166E+06
8	1.419E+07	38	3.012E+06
9	1.384E+07	39	2.865E+06
10	1.359E+07 (1.361E+7)	40	2.725E+06
11	1.252E+07	41	2.592E+06
12	1.221E+07	42	2.466E+06
13	1.162E+07	43	2.385E+06
14	1.105E+07	44	2.365E+06
15	1.051E+07	45	2.346E+06
16	1.000E+07	46	2.307E+06
17	9.512E+06	47	2.231E+06
18	9.048E+06	48	2.122E+06
19	8.607E+06	49	2.019E+06
20	8.187E+06	50	1.920E+06
21	7.788E+06	51	1.827E+06
22	7.408E+06	52	1.738E+06
23	7.047E+06	53	1.653E+06
24	6.703E+06	54	1.572E+06
25	6.592E+06	55	1.496E+06
26	6.376E+06	56	1.423E+06
27	6.065E+06	57	1.353E+06
28	5.769E+06	58	1.287E+06
29	5.488E+06	59	1.225E+06
30	5.220E+06	60	1.165E+06

Table 2-1: Continued

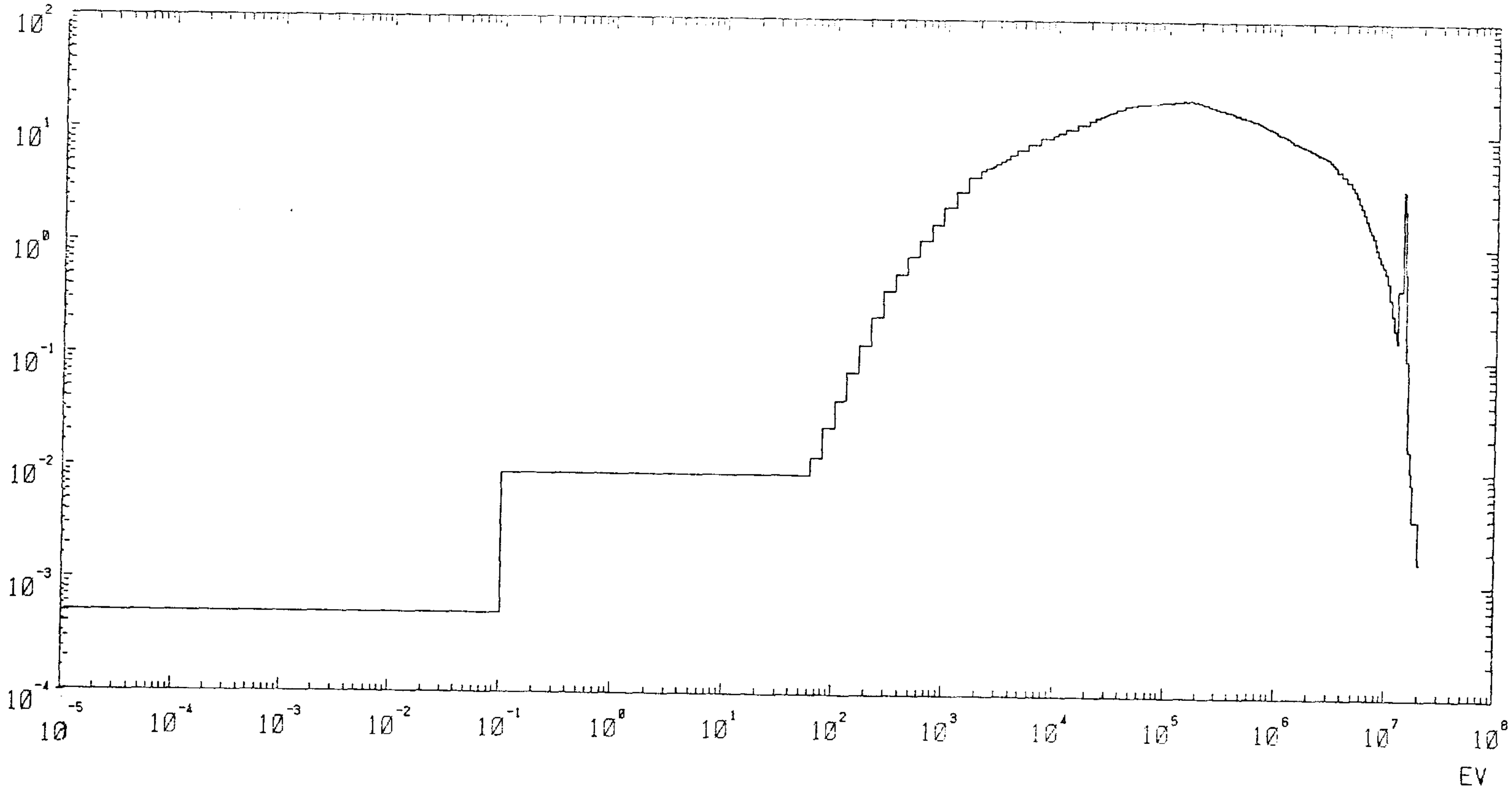
Group Number	Group Limit E (Top)	Group Number	Group Limit E (Top)
61	1.108E+06	91	2.128E+05
62	1.003E+06	92	2.024E+05
63	9.616E+05	93	1.925E+05
64	9.072E+05	94	1.832E+05
65	8.629E+05	95	1.742E+05
66	8.208E+05	96	1.657E+05
67	7.808E+05	97	1.576E+05
68	7.427E+05	98	1.500E+05
69	7.065E+05	99	1.426E+05
70	6.721E+05	100	1.357E+05
71	6.393E+05	101	1.291E+05
72	6.081E+05	102	1.228E+05
73	5.784E+05	103	1.168E+05
74	5.502E+05	104	1.111E+05
75	5.234E+05	105	9.804E+04
76	4.979E+05	106	8.652E+04
77	4.505E+05	107	8.250E+04 (8.230E+4)
78	4.076E+05	108	7.950E+04 (8.027E+4)
79	3.877E+05	109	7.200E+04 (7.263E+4)
80	3.688E+05	110	6.738E+04
81	3.337E+05	111	5.656E+04
82	3.020E+05	112	5.248E+04
83	2.985E+05 (2.995E+5)	113	4.631E+04
84	2.972E+05 (2.970E+5)	114	4.087E+04
85	2.945E+05	115	3.431E+04
86	2.872E+05	116	3.183E+04
87	2.732E+05	117	2.850E+04 (2.880E+4)
88	2.472E+05	118	2.700E+04 (2.740E+4)
89	2.352E+05	119	2.606E+04
90	2.237E+05	120	2.479E+04

Table 2-1: Continued

Group Number	Group Limit E (Top)		Group Number	Group Limit E (Top)	
121	2.418E+04		148	2.145E+02	
122	2.358E+04		149	1.670E+02	
123	2.187E+04		150	1.301E+02	
124	1.390E+04		151	1.013E+02	
125	1.503E+04		152	7.889E+01	
126	1.171E+04		153	6.144E+01	
127	1.059E+04	(1.008E+4)	154	4.785E+01	
128	9.119E+03		155	3.727E+01	
129	7.102E+03		156	2.902E+01	
130	5.531E+03		157	2.260E+01	
131	4.307E+03		158	1.760E+01	
132	3.707E+03		159	1.371E+01	
133	3.355E+03		160	1.068E+01	
134	3.035E+03		161	8.315E+00	
135	2.747E+03		162	6.476E+00	
136	2.613E+03		163	5.043E+00	
137	2.485E+03		164	3.928E+00	
138	2.249E+03		165	3.059E+00	
139	2.035E+03		166	2.382E+00	
140	1.585E+03		167	1.855E+00	
141	1.234E+03		168	1.445E+00	(1.458E+0)
142	9.611E+02		169	1.125E+00	
143	7.485E+02		170	8.764E-01	
144	5.829E+02		171	6.826E-01	(6.850E-1)
145	4.540E+02		172	5.316E-01	(5.350E-1)
146	3.536E+02		173	4.140E-01	
147	2.754E+02		174	1.000E-01	(1.050E-1)
			Emin	1.000E-05	

*) Marked in parentheses are those boundaries in our group structure which differ slightly from VITAMIN-E

**) E+7 means 10^7



<u>Fig. 2-1:</u> Multigroup VITAMIN-E Structured Weighting Spectrum used in the Present Analysis, per Unit of Lethargy, Normalized to Arbitrary Units

3 BENCHMARK SPECIFICATIONS AND COMPUTATIONAL RESULTS

3.1 JEZEBEL, a bare sphere of plutonium

JEZEBEL is a bare sphere of plutonium metal. A single-region, simple geometry and uniform composition conveniently facilitate calculational testing, especially for the plutonium isotope cross sections in the fission source energy range.

The spherical homogeneous model has a core radius of 6.385 cm and the following composition:

Isotope	Density, nuclei/b-cm
Pu-239	0.037050
Pu-240	0.001751
Pu-241	0.000117
Ga	0.001375

Transport calculations were performed using 40 mesh intervals in the core and a vacuum boundary condition on the core boundary. Table 3.1.1 summarizes results from the computations and from experimental measurements. These are compared with previously obtained ENDF/B-V values. Fig. 3.1.1 depicts neutron spectrum at core centre of JEZEBEL.

Table 3.1.1: Eigenvalue and Spectral Indices at Core Centre of JEZEBEL Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.000 ±0.002	1.0111	1.0095	1.0111	1.0095
F28/F25	0.2137±0.0023	0.1959	0.2085	0.9167	0.9757
F23/F25	1.578 ±0.027	1.5570	1.4994	0.9867	0.9185
F37/F25	0.962 ±0.016	0.9515	0.9268	0.9891	0.9634
F49/F25	1.448 ±0.029	1.4080	1.4304	0.9724	0.9878
CV/F25	0.0023±0.003	0.0018	0.0016	0.7826	0.6957
CMn55/F25	0.0024±0.003	0.0028	0.0033	1.1667	1.3750
CCu/F25	0.0100±0.0006	0.0084	0.0083	0.8400	0.8300
CNb93/F25	0.023 ±0.002	0.0271	0.0266	1.1783	1.1565
CAu197/F25	0.083 ±0.002	0.0791	0.0779	0.9530	0.9386

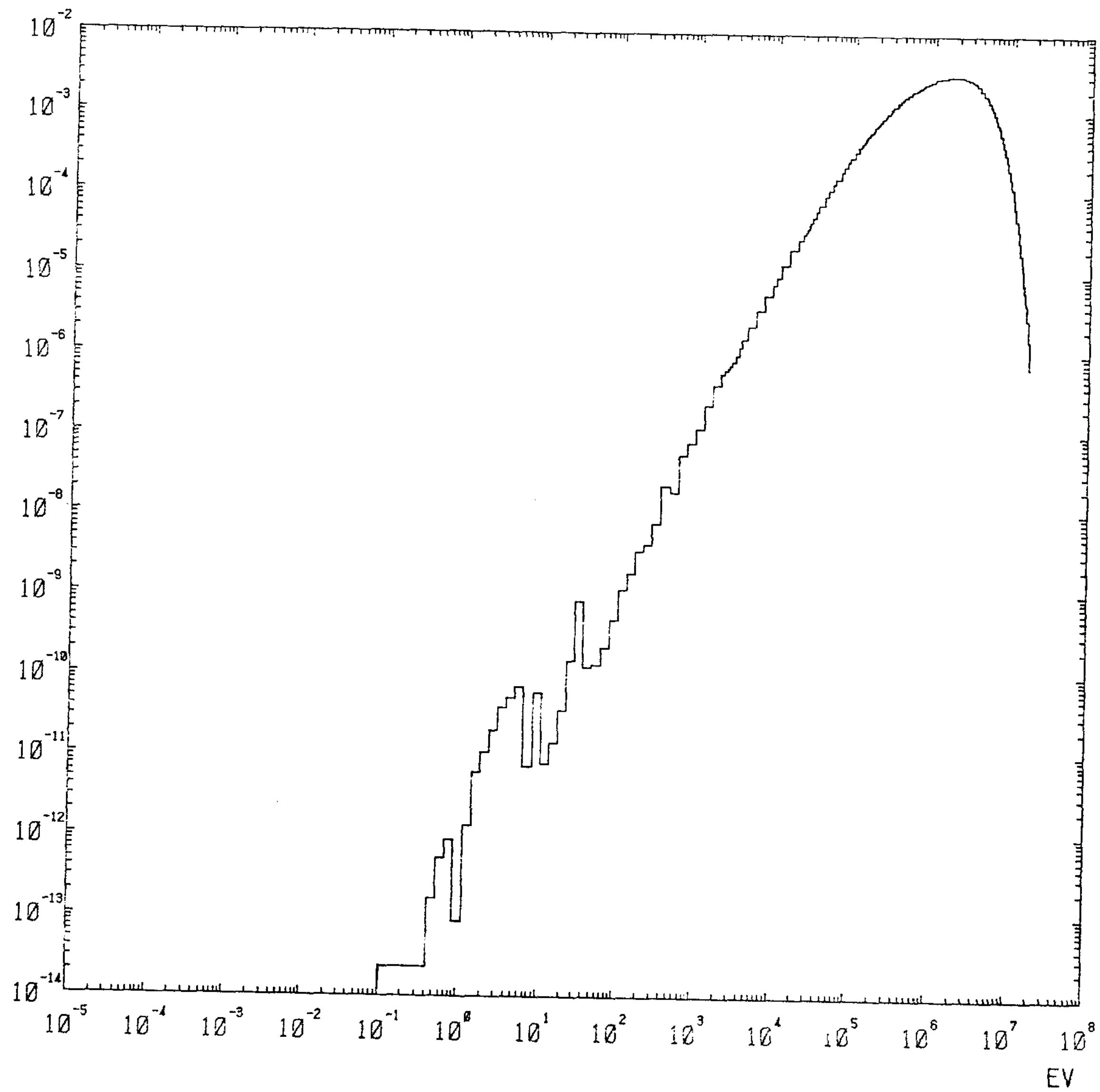


Fig. 3.1.1: Neutron Spectrum at the Centre of JEZEBEL Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library.

3.2 VERA-11A, a plutonium plus graphite assembly

VERA-11A is a cylindrically shaped critical assembly fueled with plutonium and diluted with graphite. Assembly core height was 21.7 cm and the effective core diameter was 26.9 cm. The core region was surrounded by a blanket consisting of depleted uranium and stainless steel. This assembly was designed to explore the accuracy of the plutonium 239 neutron cross section data.

The spherical one-dimensional model consists of a 13.99 cm thick core surrounded by a 43 cm thick reflector. Following composition is used.

Material	Core	Reflector
Pu-239	0.007213	-
Pu-240	0.000370	-
Pu-241	0.000028	-
Ga	0.000449	-
C	0.046204	-
Fe	0.006084	0.00650
Cr	0.001579	0.00170
Ni	0.000665	0.00071
Cu	0.007402	-
U-235	-	0.00025
U-238	-	0.03440
Pb	0.000035	-
Sn	0.000043	-
H	0.000033	-

Transport calculation was performed using 40 meshes in the core and 40 meshes in the reflector respectively, with a vacuum boundary condition on the outer boundary. Results are compared with the experiment and with those obtained employing the ENDF/B-V data files (see Table 3.2.1). Fig. 3.2.1 depicts neutron spectrum at centre of VERA-11A assembly.

Table 3.2.1: Eigenvalue and Spectral Indices at Core Centre of VERA-11A Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment

	Measurement	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.000 ±0.003	0.9884	0.9860	0.9884	0.9860
F28/F25	0.077 ±0.002	0.0918	0.0940	1.1922	1.2208
F49/F25	1.07 ±0.02	1.1810	1.1969	1.1037	1.1186
F40/F25	0.475 ±0.020	0.5402	0.5371	1.1373	1.1307
F37/F25	0.43 ±0.02	0.5281	0.5006	1.2281	1.2422
F23/F25	1.49 ±0.03	1.5190	1.4989	1.0195	1.0060

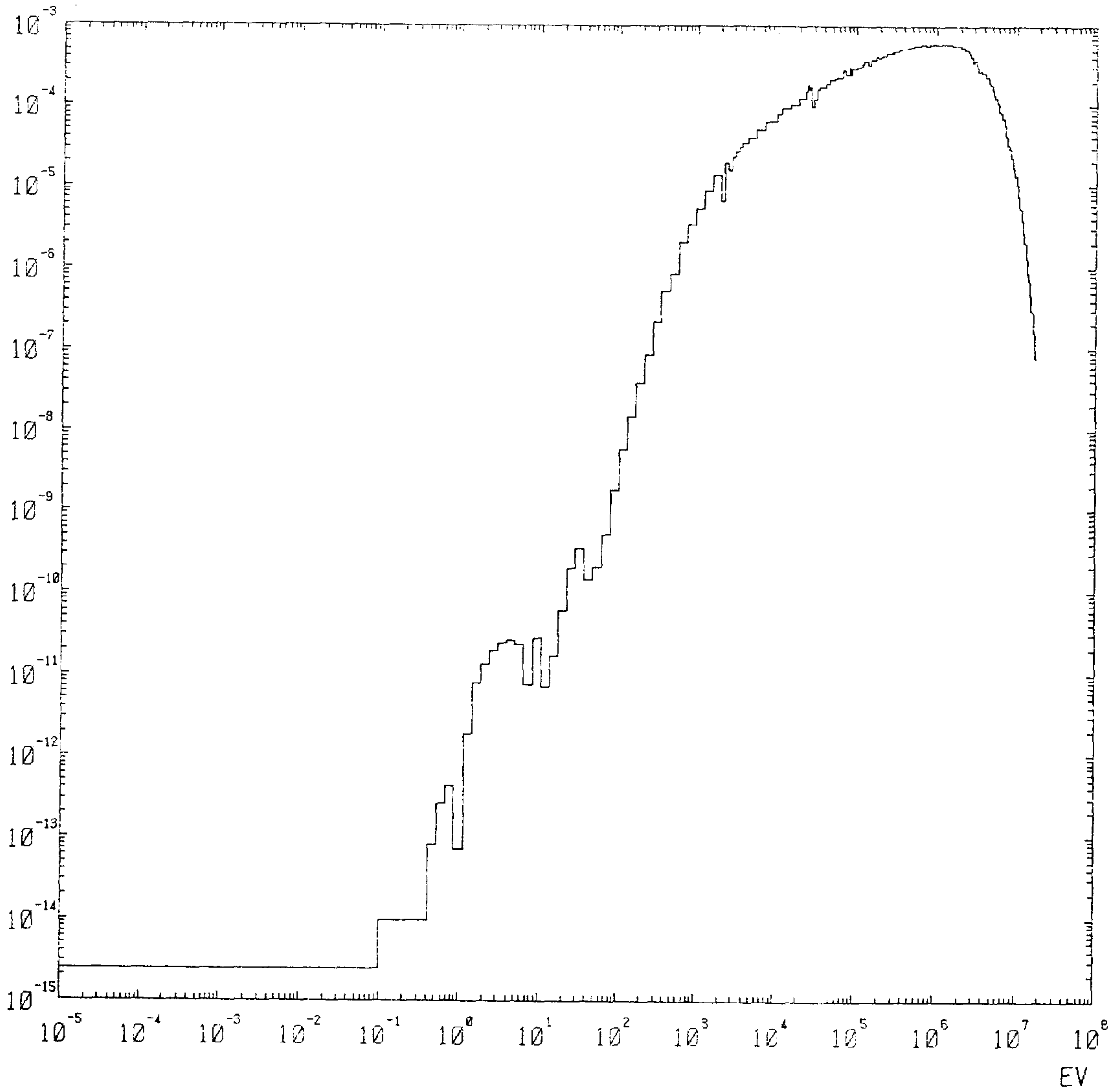


Fig. 3.2.1: Neutron Spectrum at Centre of VERA-11A Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library.

3.3 GODIVA, a bare sphere of enriched uranium

GODIVA, as a bare sphere of enriched uranium metal, is especially suited for testing U-235 and U-238 cross sections in the fission source energy range. The single-region, simple geometry and uniform composition conviently facilitate calculational testing.

The spherical homogeneous model has a core radius of 8.741 cm and the following compositions:

Isotope	Density, nuclei/b-cm
U-235	0.045000
U-238	0.002498
U-234	0.000492

Transport calculations were performed using 40 mesh intervals and a vacuum boundary condition on the outer core coundary. Results are compared with those from ENDF/B-V data files and with experimental values (see Table 3.3.1). Fig. 3.3.1 depicts neutron spectrum at core centre of GODIVA.

Table 3.3.1: Eigenvalue and Spectral Indices at Core Centre of GODIVA Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment.

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.000 ±0.001	1.0028	0.9995* (0.9993**)	1.0028	0.9995
F28/F25	0.1647±0.0018	0.1707	0.1745	1.0364	1.0595
F23/F25	1.59 ±0.03	1.5670	1.5129	0.9855	0.9515
F37/F25	0.837 ±0.013	0.8906	0.8510	1.0640	1.0167
F49/F25	1.402 ±0.025	1.3940	1.4126	0.9943	1.0076
CMn55/F25	0.0027±0.0002	0.0030	0.0036	1.1111	1.3333
CCo59/F25	0.038 ±0.003	0.0059	0.0059	1.5526	1.5526
CNb93/F25	0.030 ±0.003	0.0296	0.0300	0.9867	1.0000
CAu197/F25	0.100 ±0.002	0.0855	0.0867	0.8550	0.8670
CCu/F25	0.0117±0.0006	0.0088	0.0099	0.7521	0.8462

* χ converged
** First iteration for determining χ

Furthermore GODIVA experiment was considered to investigate the influence of angular approximation on the eigenvalues of critical experiments. Table 3.3.2 shows that the use of S_{16} in the transport calculations is suitable, beeing the eigenvalue difference between the S_{16} and S_{32} calculations less than 1 mk.

Table 3.3.2: Eigenvalue of GODIVA Estimated Using Different Angular Approximations

Order of Approximation	S_8	S_{16}	S_{32}
k-eff	1.0013	0.9993	0.9990

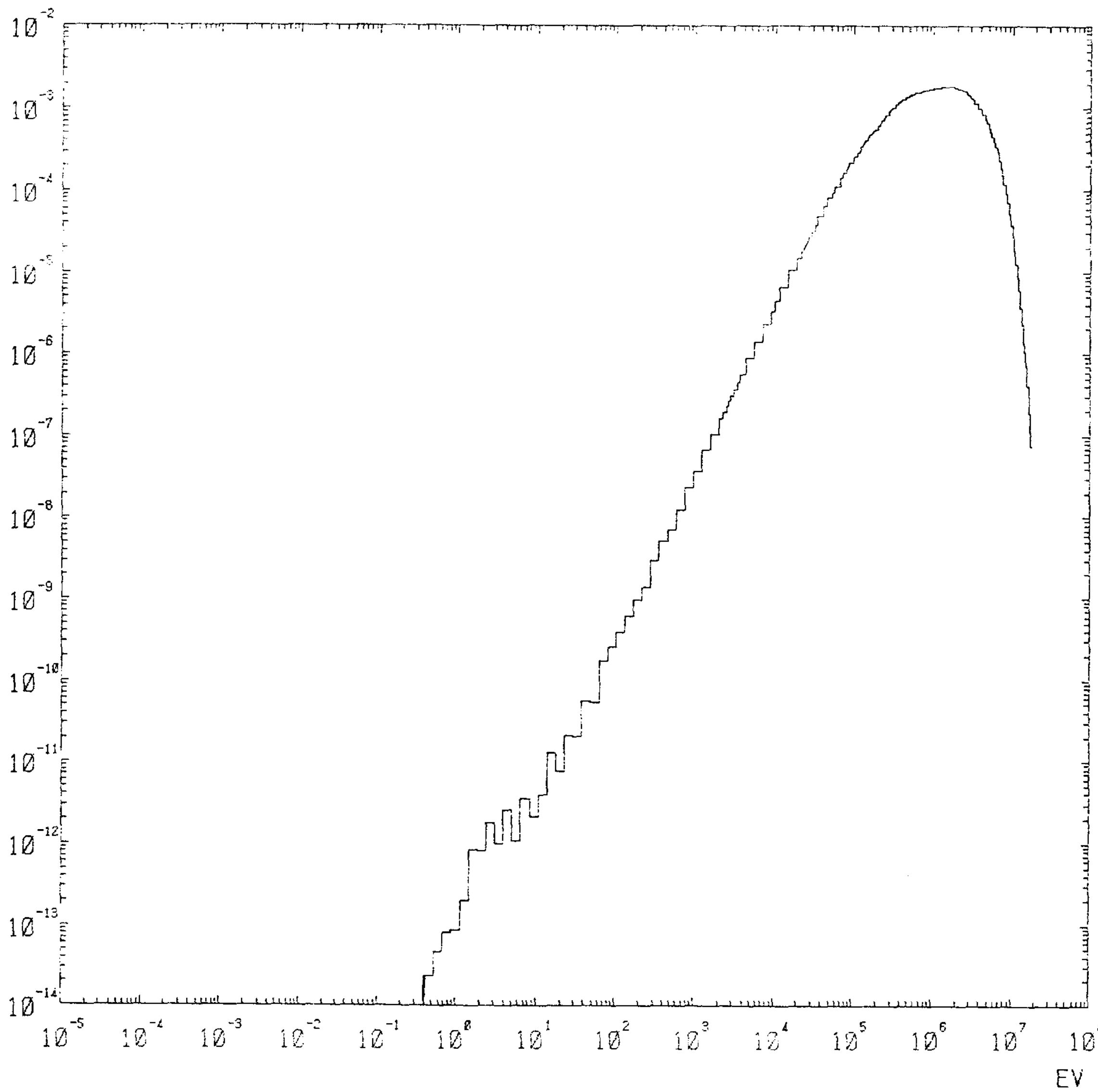


Fig. 3.3.1: Neutron Spectrum at Centre of GODIVA Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.4 JEZEBEL-23, a bare sphere of U(98.13 at. %233U)

JEZEBEL-23 as a bare sphere of U(98.13 at. %233U) metal, is especially suited for testing U-233 cross sections in the fission source energy range. The single-region, simple geometry and uniform composition facilitate calculational testing.

The spherical homogeneous model has a core radius of 5.983 cm and the following composition:

Isotope	Density, nuclei/b-cm
U-233	0.04671
U-234	0.00059
U-235	0.00001
U-238	0.00029

Transport calculations were performed using 40 mesh intervals in the core and a vacuum boundary condition on the outer core boundary. Results are compared with experiment (see Table 3.4.1). Fig. 3.4.1 despicts neutron spectrum at core centre of JEZEBEL-23 Assembly.

Table 3.4.1: Eigenvalue and Spectral Indices at Core Centre of JEZEBEL-23 Assembly Estimated Using JEF-1 Data Files. Comparison with Experiment.

	Experiment	JEF-1	JEF-1 / exp.
k-eff	1.000 ±0.001	0.9620	0.9620
F28/F25	0.2131±0.0023	0.1959	0.9193
F37/F25	0.977 ±0.016	0.8973	0.9184

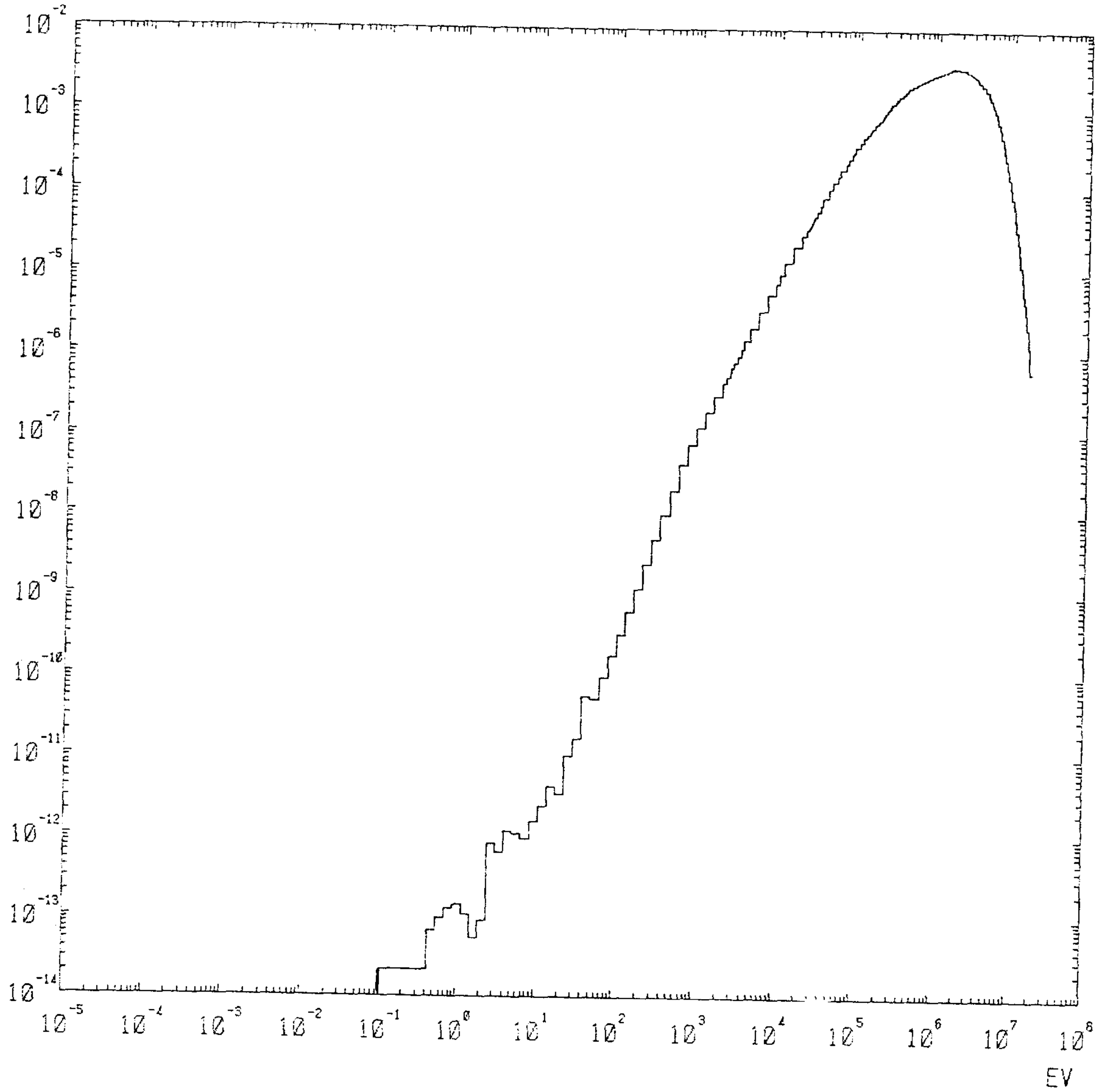


Fig. 3.4.1: Neutron Spectrum at Centre of JEZEBEL-23 Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.5 BIG TEN, a reflected cylinder of uranium containing 10% U-235

BIG TEN is a cylindrical system consisting of a uranium-metal core, averaging 10 wt% U-235, reflected by depleted-uranium metal. The core has a homogeneous axial region surrounded by interleaved plates of highly enriched uranium and natural uranium such that the average U-235 content is uniform.

Composition:

Isotope	Core	Reflector
U-234 nuclei/b-cm	0.00005	0.00000
U-235 nuclei/b-cm	0.00484	0.00010
U-238 nuclei/b-cm	0.04268	0.04797

The spherical model consists of a core of radius 30.48 cm surrounded by a 15.24 cm thick reflector. Transport calculations were performed with 40 fine meshes in the core and 20 in the reflector with a vacuum boundary condition on the outer reflector zone. Results are compared with experiment (see Table 3.5.1). Fig. 3.5.1 depicts neutron spectrum of BIG TEN assembly at core centre.

Table 3.5.1: Eigenvalue and Spectral Indices at Core Centre of BIG TEN Assembly Estimated Using JEF-1 Data Files. Comparison with Experiment.

	Experiment	JEF-1	JEF-1/exp.
k-eff	0.996 $\pm$0.003	0.9976	1.0016
F28/F25	0.0373$\pm$0.0004	0.0385	1.0322
F37/F25	0.316 $\pm$0.005	0.2998	0.9487
F49/F25	1.185 $\pm$0.020	1.1888	1.0032
F23/F25	1.580 $\pm$0.030	1.5312	0.9691
C28/F25	0.110 $\pm$0.003	0.1116	1.0145
CCo59/F25	0.0095$\pm$0.0002	0.0095	1.0000
CAu197/F25	0.167 $\pm$0.003	0.1610	0.9641
Li6(n,α)/F25	0.71 $\pm$0.01	0.6553	0.9230
B10(n,α)/F25	1.011 $\pm$0.014	0.8996	0.8898
Al27(n,α)/F25	$7.8*10^{-5}\pm0.2*10^{-5}$	$8.1*10^{-5}$	1.0385
CSc45/F25	0.0132$\pm$0.003	0.0144	1.0909
Ti46(n,p)/F25	0.0013$\pm$0.00003	0.0014	1.0769
Ti47(n,p)/F25	0.00215$\pm$0.00003	0.0027	1.2558
Ti48(n,p)/F25	$3.6*10^{-5}\pm0.1*10^{-5}$	$3.5*10^{-5}$	0.9722
Fe54(n,p)/F25	0.0090$\pm$0.0003	0.0097	1.0778
CFe58/F25	0.0031$\pm$0.0001	0.0027	0.8710
Ni58(n,p)/F25	0.0123$\pm$0.0002	0.0127	1.0325
CCu63/F25	0.0164$\pm$0.0010	0.0168	1.0244
In115(n,n')/F25	0.0271$\pm$0.0006	0.0280	1.0332

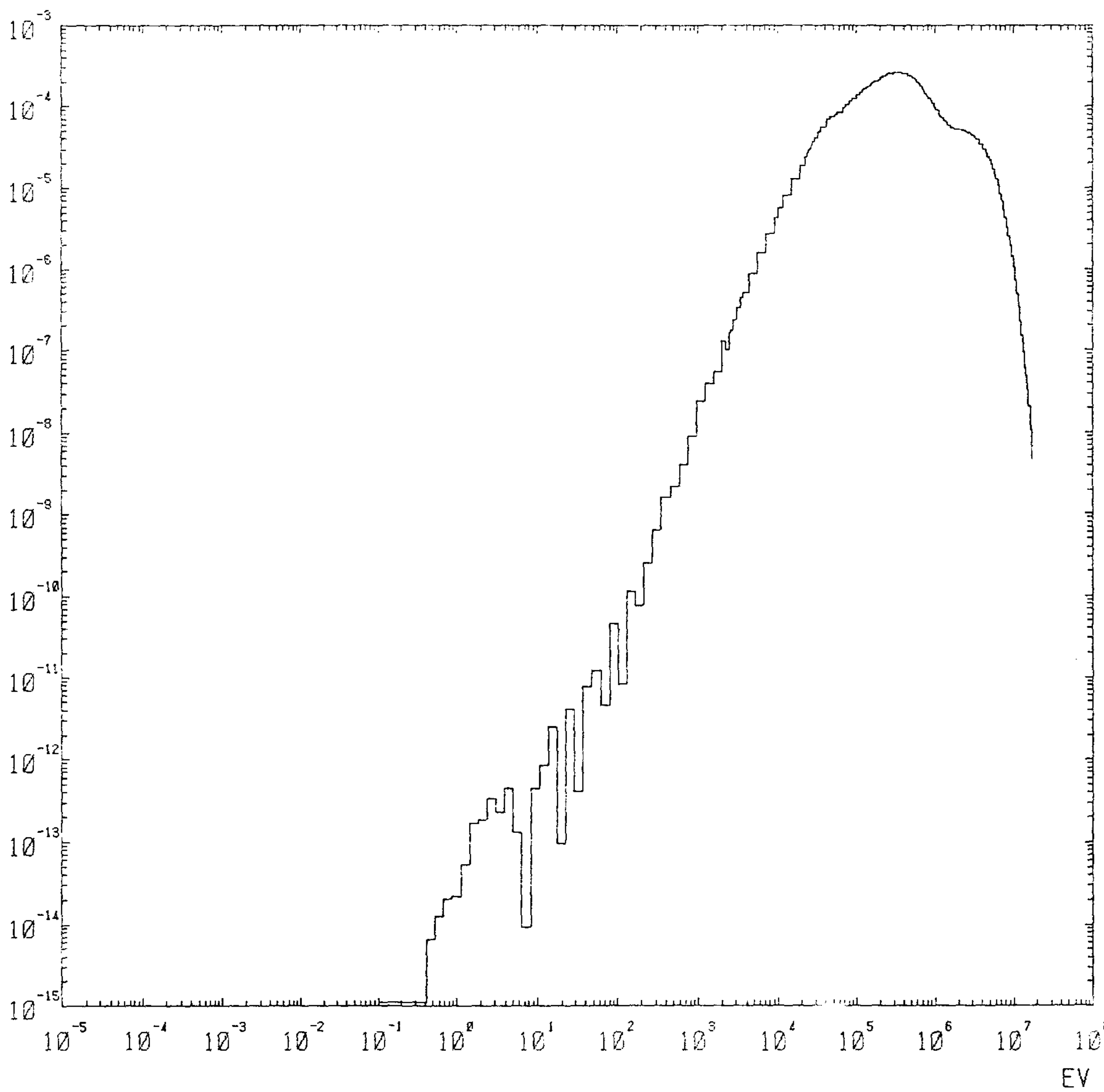


Fig. 3.5.1: Neutron Spectrum at Centre of BIG TEN Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.6 FLATTOP-25, a reflected sphere of enriched uranium

FLATTOP-25 is a spherical metallic system consisting of a highly enriched uranium core in a thick natural uranium reflector. In supplementing GODIVA, it emphasizes U-238 transport in the fission-source energy range.

The spherical model is a core of radius 6.116 cm, surrounded intimately by a reflector of radius 24.13 cm and has the following compositions:

Isotope	Core	Reflector
U-234 nuclei/b-cm	0.00049	0.00000
U-235 nuclei/b-cm	0.04449	0.00034
U-238 nuclei/b-cm	0.00270	0.04774

Transport calculations were performed using 30 fine meshes in the core and 30 in the reflector, with a vacuum boundary condition on the outer reflector boundary. Results are compared with experiment and with the values obtained using ENDF/B-V basic evaluation (see Table 3.6.1). Fig. 3.6.1 depicts neutron spectrum at core centre of FLATTOP-25.

Table 3.6.1: Eigenvalue and Spectral Indices at Core Centre of FLATTOP-25 Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V Results and with Experiment.

	Measurement	ENDF/B-V	JEF-1	$\frac{\text{ENDF/B-V}}{\text{exp.}}$	$\frac{\text{JEF-1}}{\text{exp.}}$
k-eff	1.000 ±0.001	1.0149	0.9984	1.0149	0.9984
F23/F25	1.60 ±0.03	-	1.5161	-	0.9476
F28/F25	0.149 ±0.002	0.1547	0.1582	1.0383	1.0617
F37/F25	0.76 ±0.010	0.8260	0.7832	1.0868	1.0305
F49/F25	1.37 ±0.02	1.371	1.3873	1.0007	1.0126

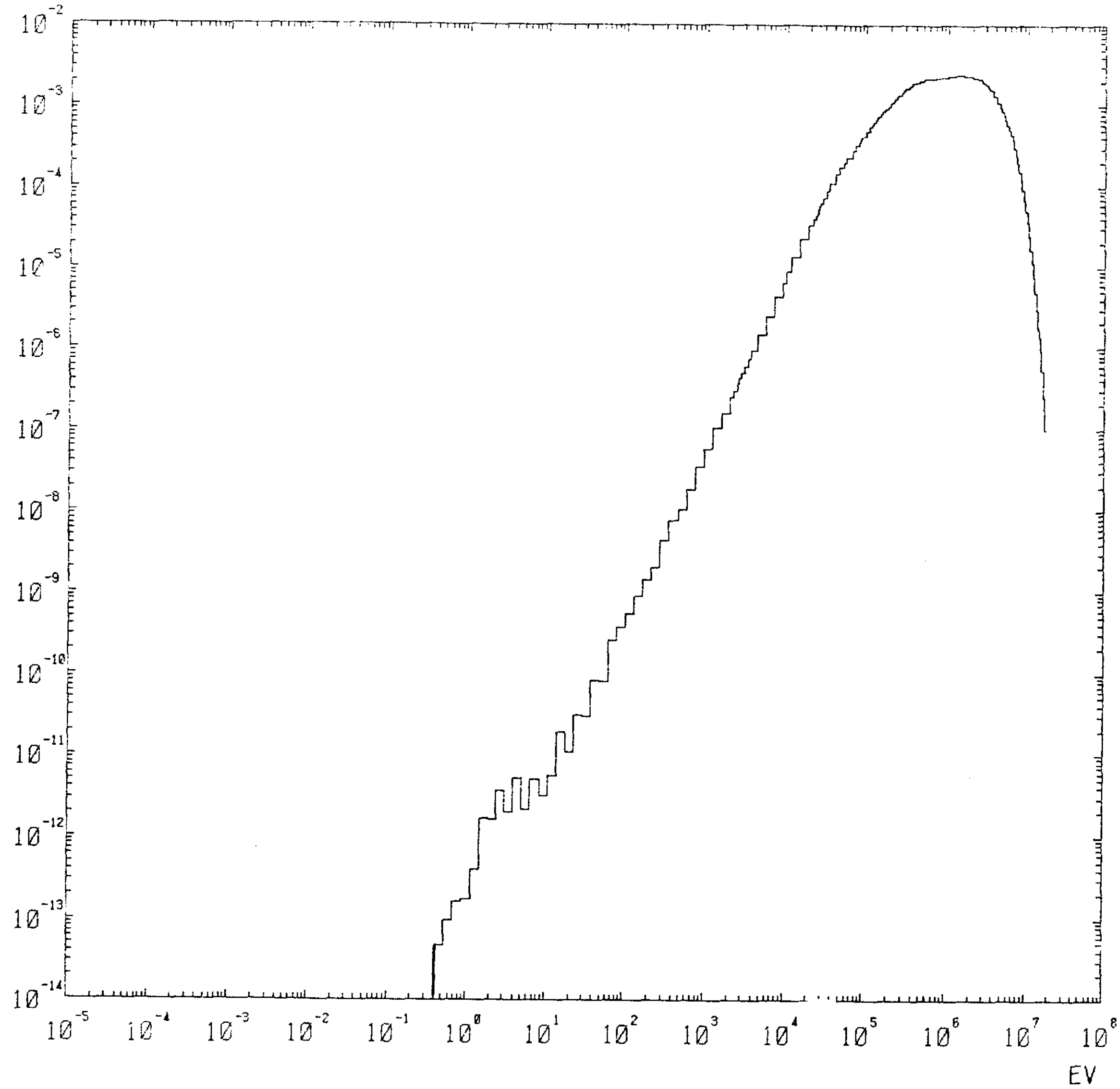


Fig. 3.6.1: Neutron Spectrum at Centre of FLATTOP-25 Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.7 FLATTOP-23, a reflected U-233 sphere

FLATTOP-23 is a spherical metallic system consisting of a U-233 (98.13%) core in a thick natural uranium reflector, with 0.293 cm gap between core and reflector. In supplementing JEZEBEL-23, it emphasizes U-238 transport in the fission-source energy range.

The spherical model is a core of radius 4.317 cm, centred in a reflector of 4.610 cm inner radius and 24.13 cm outer radius, and has the following compositions:

Isotope	Core	Reflector
U-233 nuclei/b-cm	0.04671	-
U-234 nuclei/b-cm	0.00059	-
U-235 nuclei/b-cm	0.00001	0.00034
U-238 nuclei/b-cm	0.00028	0.04774

Transport calculations were performed using 30 mesh intervals in the core, 2 in the gap, 30 in the reflector and a vacuum boundary condition on the outer reflector surface. Results are compared with experiment (see Table 3.7.1). Fig. 3.7.1 depicts neutron spectrum at core centre of FLATTOP-23.

Table 3.7.1: Eigenvalue and Spectral Indices at Core Centre of FLATTOP-23 Assembly Estimated Using JEF-1 Data Files. Comparison with Experiment.

	Measurement	JEF-1	JEF-1 / exp.
k-eff	1.000 ±0.001	0.9766	0.9766
F28/F25	0.191 ±0.003	0.1753	0.9178
F37/F25	0.89 ±0.01	0.8209	0.9224

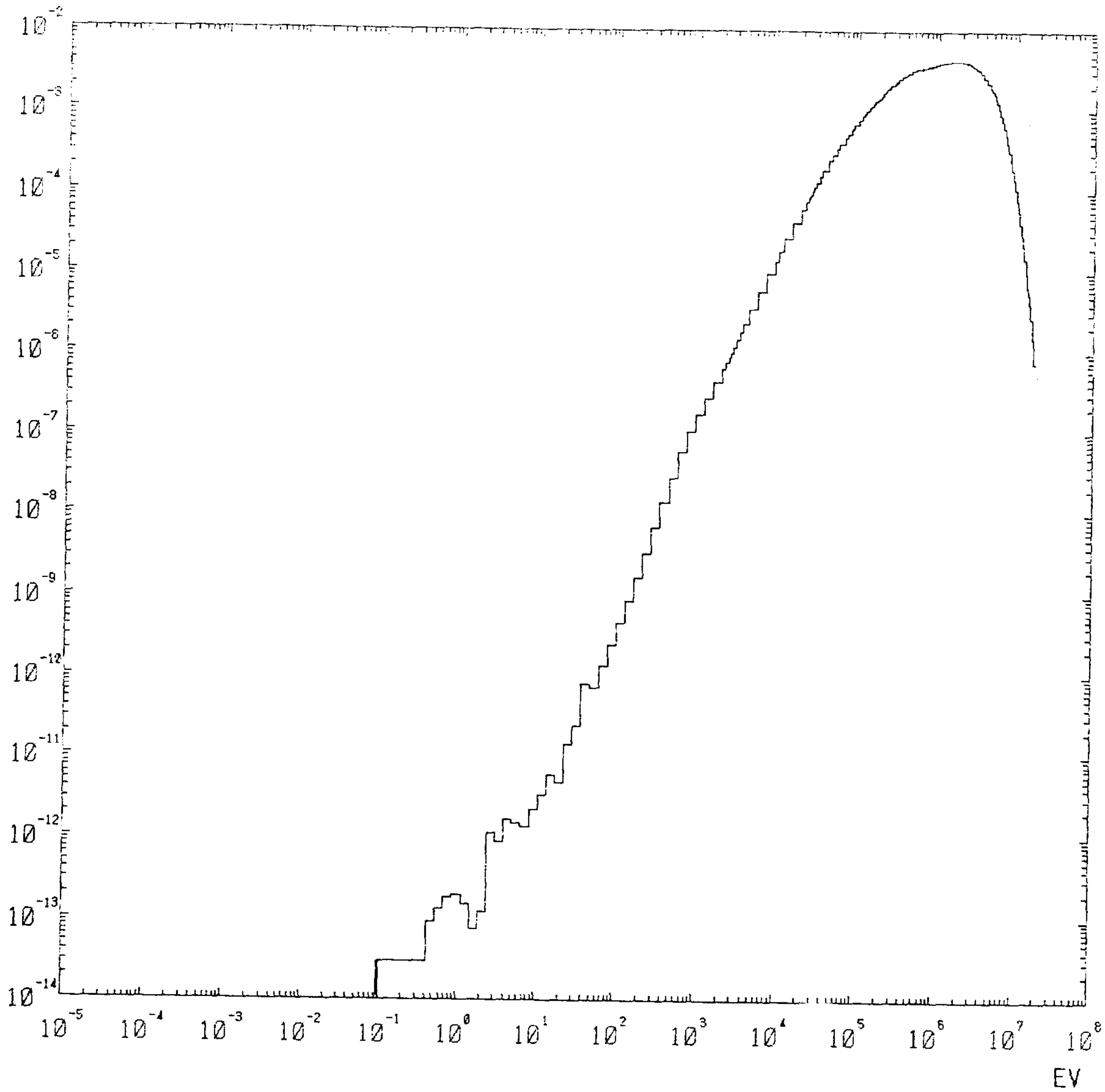


Fig. 3.7.1: Neutron Spectrum at Centre of FLATTOP-23 Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.8 THOR, a thorium-reflected Pu sphere

THOR consists of a sphere of plutonium (5.1% Pu-240) metal centred in a close fitting 53.3 cm equilateral cylinder of thorium metal. In supplementing JEZEBEL, it emphasizes Th-232 transport in the fission-source energy range.

The equivalent spherical model is a core of radius 5.310 cm centered in a reflector of 5.310 cm inner radius and 29.88 cm outer radius, and has the following compositions:

Isotope	Core	Reflector
Pu-239 nuclei/b-cm	0.03618	-
Pu-240 nuclei/b-cm	0.00194	-
Ga nuclei/b-cm	0.00133	-
Th-232 nuclei/b-cm	-	0.03005

Transport calculations were performed using 30 mesh intervals in the core, 30 in the reflector, and a vacuum boundary condition on the outer reflector surface. Results are compared with experiment (see Table 3.8.1). Fig. 3.8.1 depicts neutron spectrum at core centre of THOR assembly.

Table 3.8.1: Eigenvalue and Spectral Indices at Core Centre of THOR Assembly Estimated Using JEF-1 Data Files. Comparison with Experiment.

	Measurement	JEF-1	JEF-1 / exp.
k-eff	1.000 ±0.001	0.9923	0.9923
F28/F25	0.195 ±0.003	0.1948	0.9990
F37/F25	0.92 ±0.02	0.8864	0.9635
F02/F28	0.26 ±0.01	0.2282	0.8777
C28/F25	0.083 ±0.003	0.0668	0.8048
*N28/F25	0.053 ±0.003	0.0649	1.2245
C02/C28	1.20 ±0.06	1.4715	1.2262
*N02/N28	1.04 ±0.03	1.1174	1.0744

*) refers to (n,2n) reaction

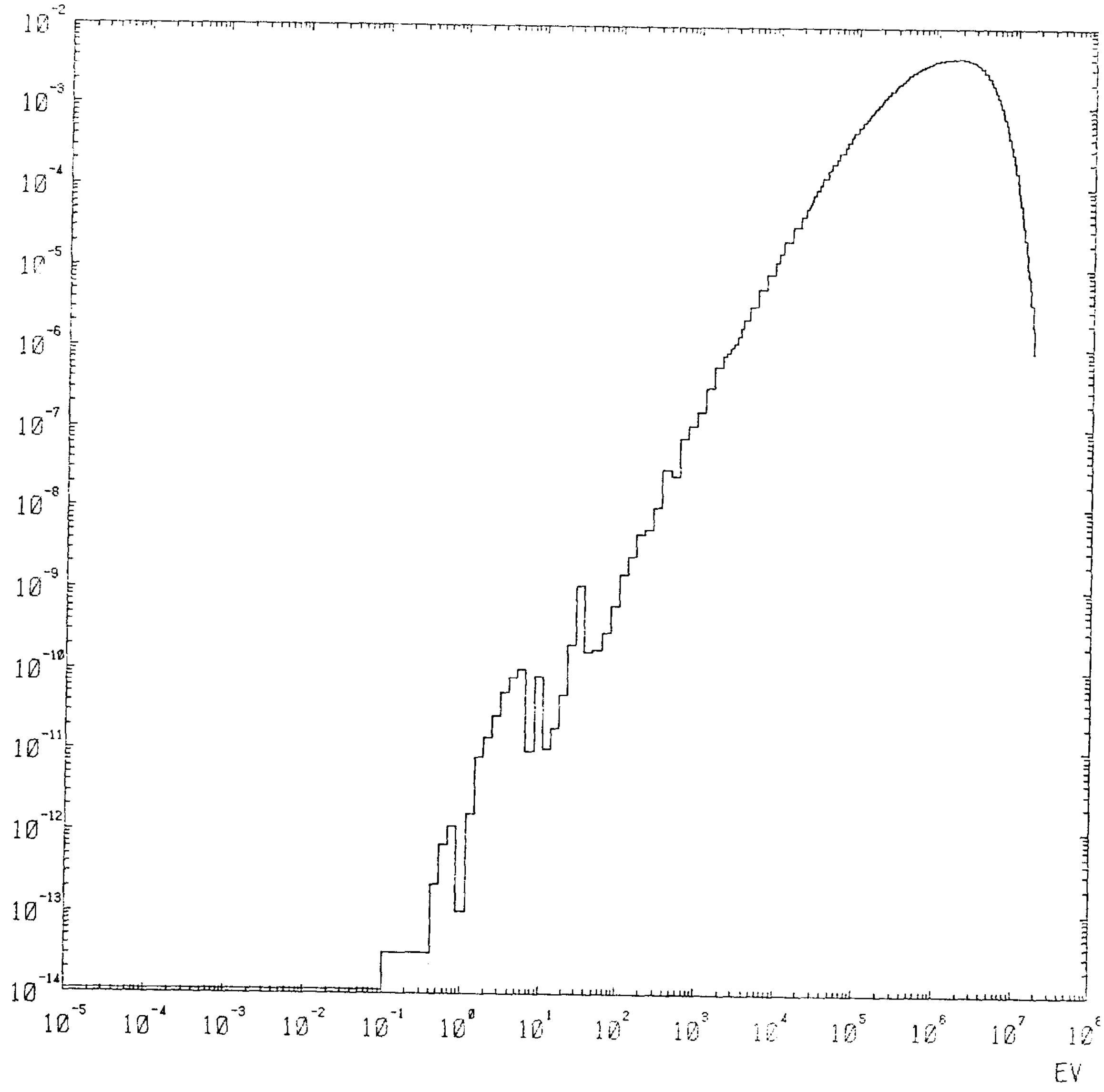


Fig. 3.8.1: Neutron Spectrum at Centre of THOR Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.9 FLATTOP-Pu, a reflected plutonium sphere

FLATTOP-Pu is a metallic system consisting of a plutonium (4.5 % Pu-240) core in a thick natural uranium reflector. In supplementing JEZEBEL, it emphasizes U-238 transport in the fission-source energy range.

The spherical model is of core radius 4.533 cm, surrounded intimately by a reflector of radius 24.13 cm, and has the following compositions:

Isotope	Core	Reflector
Pu-239 nuclei/b-cm	0.03674	-
Pu-240 nuclei/b-cm	0.00186	-
Pu-241 nuclei/b-cm	0.00012	-
Ga nuclei/b-cm	0.00138	-
U-235 nuclei/b-cm	-	0.00034
U-238 nuclei/b-cm	-	0.04774

Transport calculations were performed using 30 meshes in the core, 30 in the reflector, and a vacuum boundary on the reflector surface. Results are compared with those from the ENDF/B-V basic evaluation and with experiment (see Table 3.9.1). Fig. 3.9.1 depicts neutron spectrum at core centre of FLATTOP-Pu assembly.

Table 3.9.1: Eigenvalue and Spectral Indices at Core Centre of FLATTOP-Pu Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment.

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.000 ±0.001	1.0207	1.0054	1.0207	1.0054
F28/F25	0.180 ±0.003	0.1693	0.1772	0.9406	0.9844
F37/F25	0.84 ±0.01	0.8520	0.8131	1.0143	0.9600

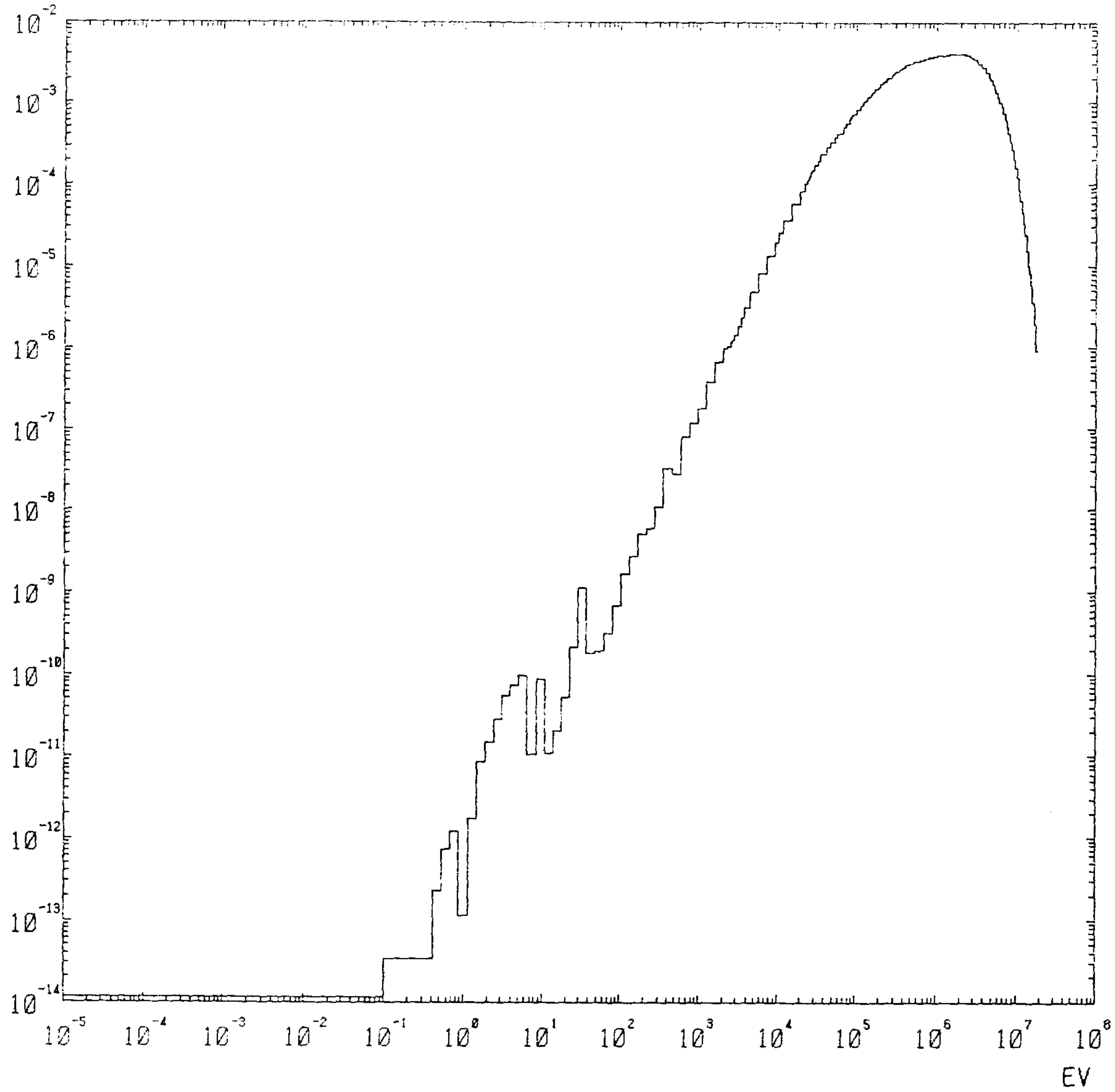


Fig. 3.9.1: Neutron Spectrum at Centre of FLATTOP-Pu Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.10 ZEBRA-3, a 9:1 uranium/plutonium metal assembly

The ZEBRA facility consists of stainless steel tubes containing reactor materials mounted vertically on a 3 meter square base plate. A pin at the lower end of each element fits into the base plate and the elements are restrained laterally by 3 steel lattice plates. The central 27 cm square of the base plate is removable so large experiments may be mounted in the reactor centre. A concrete shield and steel containment vessel complete the structure.

The spherical model is of core radius 23.68 cm, surrounded intimately by a reflector of radius 54.18 cm, and has the following composition (nuclei/barn-cm).

Material	Core	Reflector
Pu-239	0.003466	-
Pu-240	0.0001834	-
Pu-241	0.0000127	-
U-235	0.0002264	0.000298
U-238	0.031775	0.041269
Cu	0.0043702	0.000004
Fe	0.004578	0.003323
C	0.000042	0.000042
Cr	0.000864	0.000864
Mo	0.000008	0.000008
Mn	0.000064	0.000064
Ni	0.000483	0.000483
Al	0.000019	0.000019
Ti	0.000016	0.000016
Si	0.000054	0.000054
V	0.000005	0.000005

Transport calculations were performed using 40 mesh intervals in the core and 30 in the reflector, and a vacuum boundary condition on the outer reflector boundary. Results are compared with those from ENDF/B-V evaluation and with experiment (see Table 3.10.1). Fig. 3.10.1 depicts neutron spectrum at core centre of ZEBRA-3 assembly.

Table 3.10.1: Eigenvalue and Spectral Indices at Core Centre of ZEBRA-3 Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment.

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.000 ±0.003	1.0090	0.9953	1.0090	0.9953
F28/F25	0.0461±0.0008	0.0474	0.0456	1.0282	0.9892
F37/F25	0.353 ±0.004	0.3945	0.3337	1.1176	0.9453
F49/F25	1.190 ±0.014	1.2010	1.1968	1.0092	1.0057
F40/F25	0.373 ±0.005	0.4060	0.3666	1.0885	0.9828
F23/F25	1.542 ±0.019	1.5580	1.5296	1.0104	0.9920
F26/F25	0.099 ±0.005	0.1136	0.1018	1.1475	1.0283
F24/F25	0.346 ±0.009	0.3882	0.3478	1.1220	1.0051

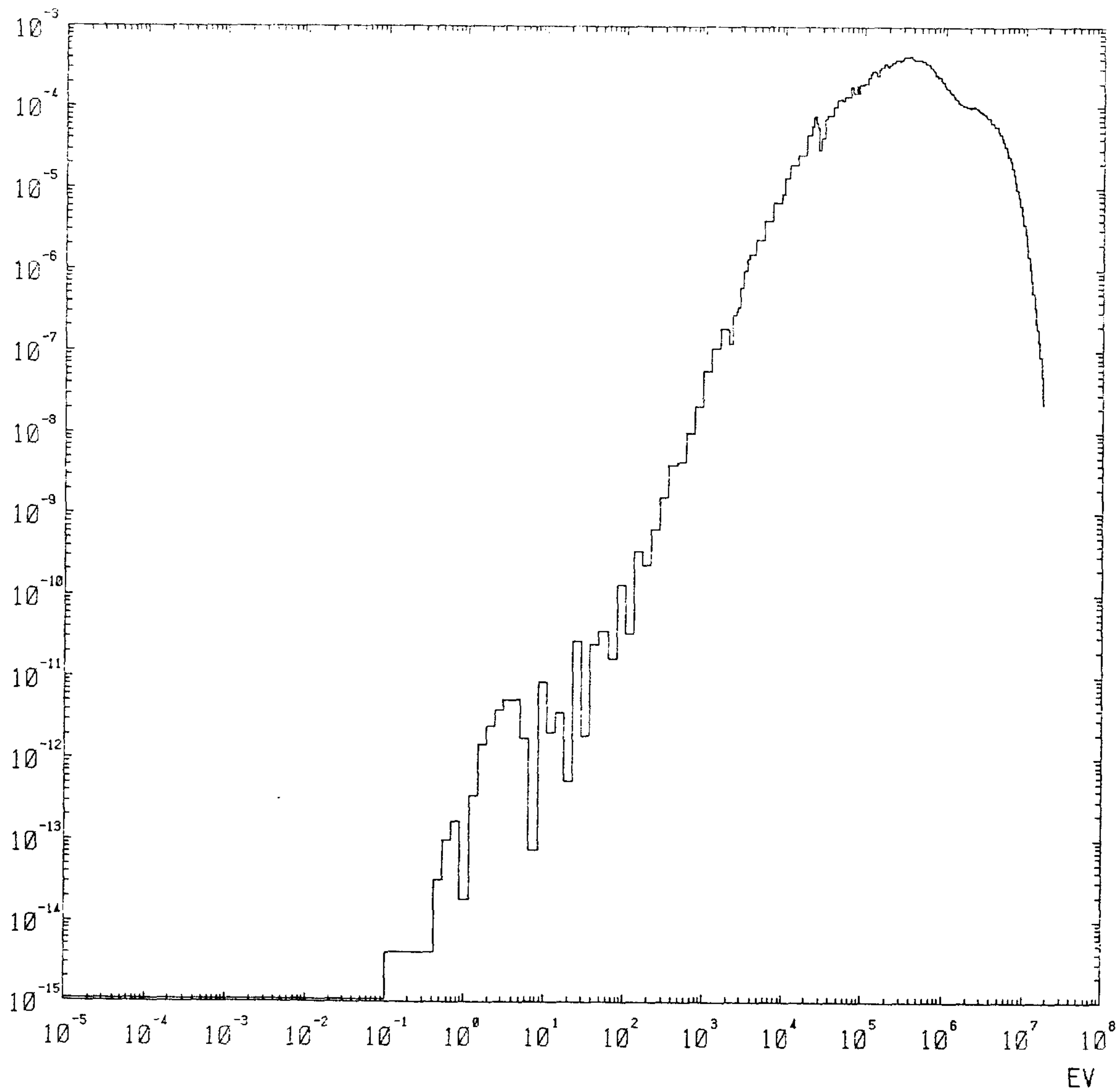


Fig. 3.10.1: Neutron Spectrum at Centre of ZEBRA-3 Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.11 ZPR-3 Assembly 12, a 4:1 uranium-graphite system, source experiment

ZPR-3 Assembly 12 was designed as a fast reactor benchmark source experiment on a 4:1 uranium-graphite system. The graphite was included to produce the softer spectra characteristic of larger power reactors. The core was approximately cylindrical composed from a repetition of a onedrawer unit cell. A blanket, consisting primarily of depleted uranium, surrounded the core. The polonium-beryllium neutron sources were removed before measurements were made.

The spherical model of ZPR-3 12 is of core radius 28.76 cm, surrounded intimately by a reflector of radius 59.26 cm, and has the following composition (nuclei/barn-cm).

Material	Core	Blanket
U-235	0.004516	0.000089
U-238	0.016948	0.040026
U-234	0.000046	-
C	0.026762	-
Fe	0.005704	0.004971
Cr	0.001419	0.001237
Ni	0.000621	0.000541
Mn	0.000059	0.000052
Si	0.000069	0.000060

Transport calculations were performed using 40 mesh intervals in the core and 30 in the reflector, and a vacuum boundary condition on the outer reflector boundary. Results are compared with those from ENDF/B-V evaluation and with experiment (see Table 3.11.1). Fig. 3.11.1 depicts neutron spectrum at core centre of ZPR-3 Assembly.

Table 3.11.1: Eigenvalue and Spectral Indices at Core Centre of ZPR-3 Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment.

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF1 / exp.
k-eff	1.000	1.0061	0.9968	1.0061	0.9968
F28/F25	0.047 ±0.002	0.0513	0.0511	1.0915	1.0872
F24/F25	0.305 ±0.012	0.3561	0.3273	1.1675	1.0731
F23/F25	1.48 ±0.03	1.5210	1.5084	1.0277	1.0192
F49/F25	1.12 ±0.02	1.1340	1.1310	1.0125	1.0098
C28/F25	0.123 ±0.005	0.1188	0.1274	0.9659	1.0358

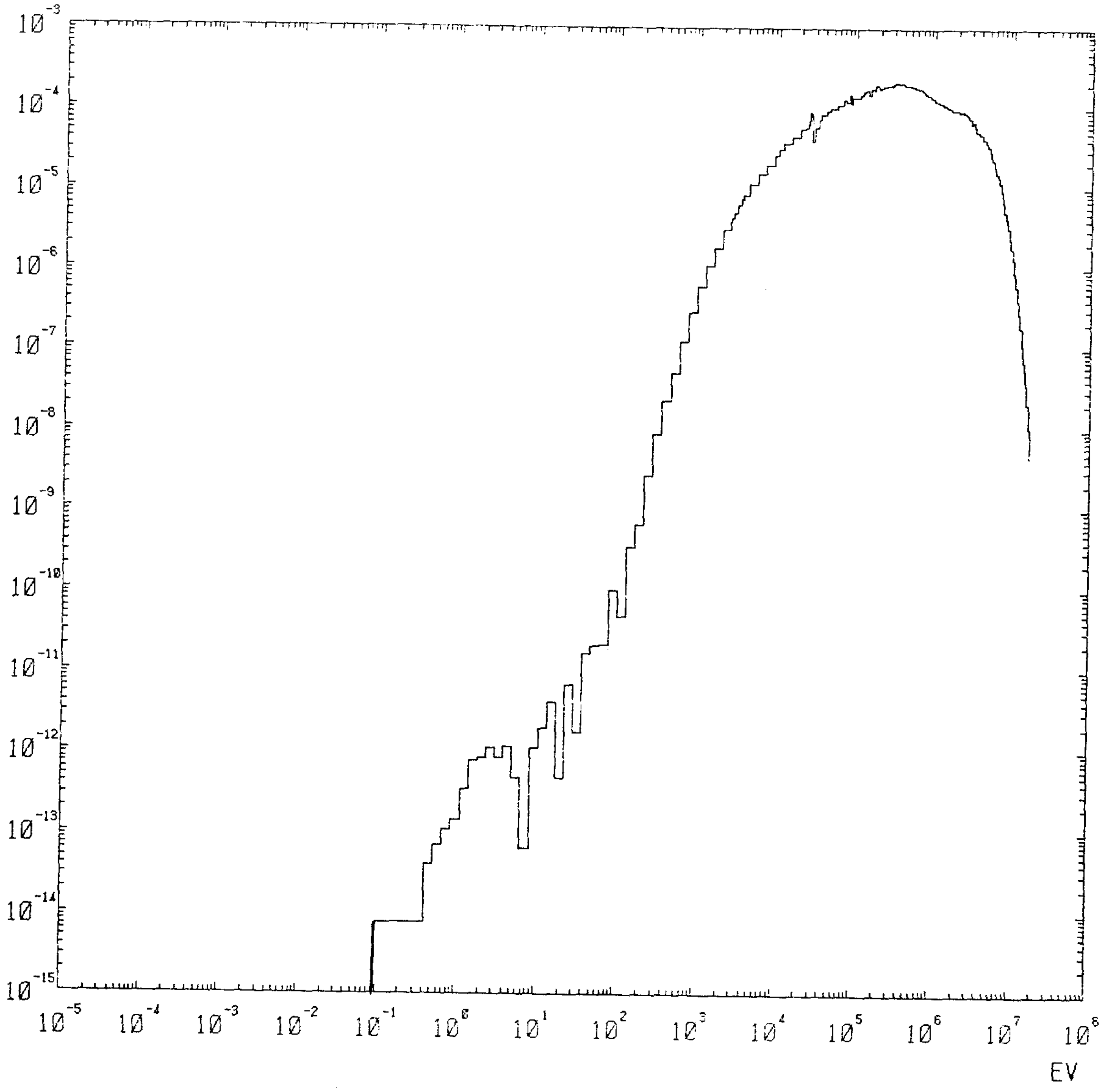


Fig. 3.11.1: Neutron Spectrum at Centre of ZPR-3 Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.12 VERA-1B, an enriched uranium-plus-graphite system

VERA-1B is a cylindrically shaped critical assembly fueled with enriched uranium and diluted with graphite. The assembly core was 27.2 cm in height and the effective core diameter was 38.1 cm. The assembly core was surrounded by a blanket of natural uranium and stainless steel. VERA-1B was designed to explore the accuracy of U-235 neutron cross section data.

The one dimensional spherical model consists of a core and reflector of thickness 19.14 and 39.45 cm respectively. It uses following compositions (nuclei/barn-cm).

Material	Core	Blanket
U-235	0.007349	0.00025
U-236	0.000014	-
U-234	0.000092	-
U-238	0.000455	0.03440
C	0.057540	-
H	0.000107	-
Fe	0.006283	0.006464
Cr	0.001635	0.001682
Ni	0.000689	0.000708

Transport calculations were performed using 40 meshes in the core and 40 in the reflector, and a vacuum boundary condition on the outer surface of the reflector. Results are compared with those from the ENDF/B-V evaluation and with the experiment. Table 3.12.1 summarizes these results. Fig. 3.12.1 depicts neutron spectrum at the core centre of VERA-1B.

Table 3.12.1: Eigenvalue and Spectral Indices at Core Centre of VERA-1B Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment

	Experiment	ENDF/B-V	JEF-1	ENDF/B-V / exp.	JEF-1 / exp.
k-eff	1.0000±0.0028	0.9923	0.9847* (0.9850**)	0.9923	0.9850
F28/F25	0.0665±0.010	0.0820	0.0835	1.2331	1.2556
F23/F25	1.433 ±0.047	1.5100	1.4952	1.0537	1.0434
F26/F25	0.134 ±0.010	0.1795	0.1767	1.3396	1.3187
F49/F25	1.070 ±0.026	1.1570	1.1671	1.0813	1.0907
F40/F25	0.399 ±0.032	0.5016	0.4993	1.2571	1.2514
F37/F25	0.38 ±0.012	0.4883	0.4631	1.2850	1.2187
C28/F25	0.131 ±0.006	0.1236	0.1237	0.9435	0.9443

* χ converged
** First iteration for determining χ

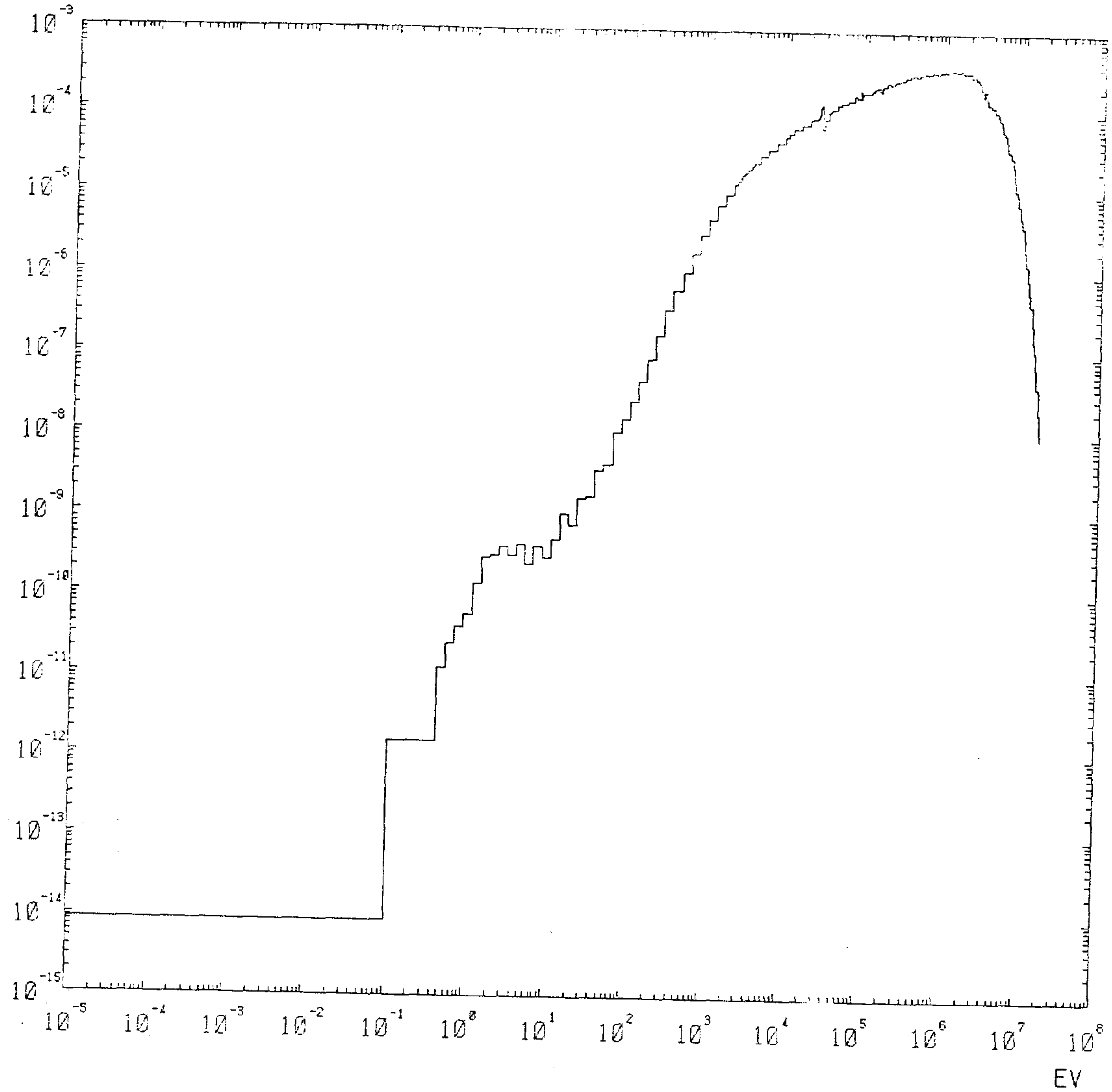


Fig. 3.12.1: Neutron Spectrum at Centre of VERA-1B Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.13 JEZEBEL-Pu(20.1), a bare sphere of plutonium with 20.1% Pu-240

JEZEBEL-Pu(20.1) is a bare sphere of plutonium metal containing 20.1 % Pu-240. In supplementing JEZEBEL, it provides information for testing Pu-240 cross sections in the fission source energy range.

The spherical homogeneous model has a core radius of 6.599 cm and the following composition.

Isotope	Density, nuclei/b-cm
Pu-239	0.02994
Pu-240	0.00788
Pu-241	0.00121
Pu-242	0.00016
Ga	0.00138

Transport calculations were performed using 40 mesh intervals and a vacuum boundary condition on the outer core surface. Results are compared with experiment (see Table 3.13.1). Fig. 3.13.1 depicts neutron spectrum at core centre of JEZEBEL-Pu.

Table 3.13.1: Eigenvalue and Spectral Indices at Core Centre of JEZEBEL-Pu Assembly Estimated Using JEF-1 Data Files. Comparison with ENDF/B-V and with Experiment.

	Measurement	JEF-1	$\frac{\text{JEF-1}}{\text{exp.}}$
k-eff	1.000 ±0.002	1.0024	1.0024
F28/F25	0.206 ±0.003	0.2021	0.9811
F37/F25	0.92 ±0.02	0.9070	0.9859

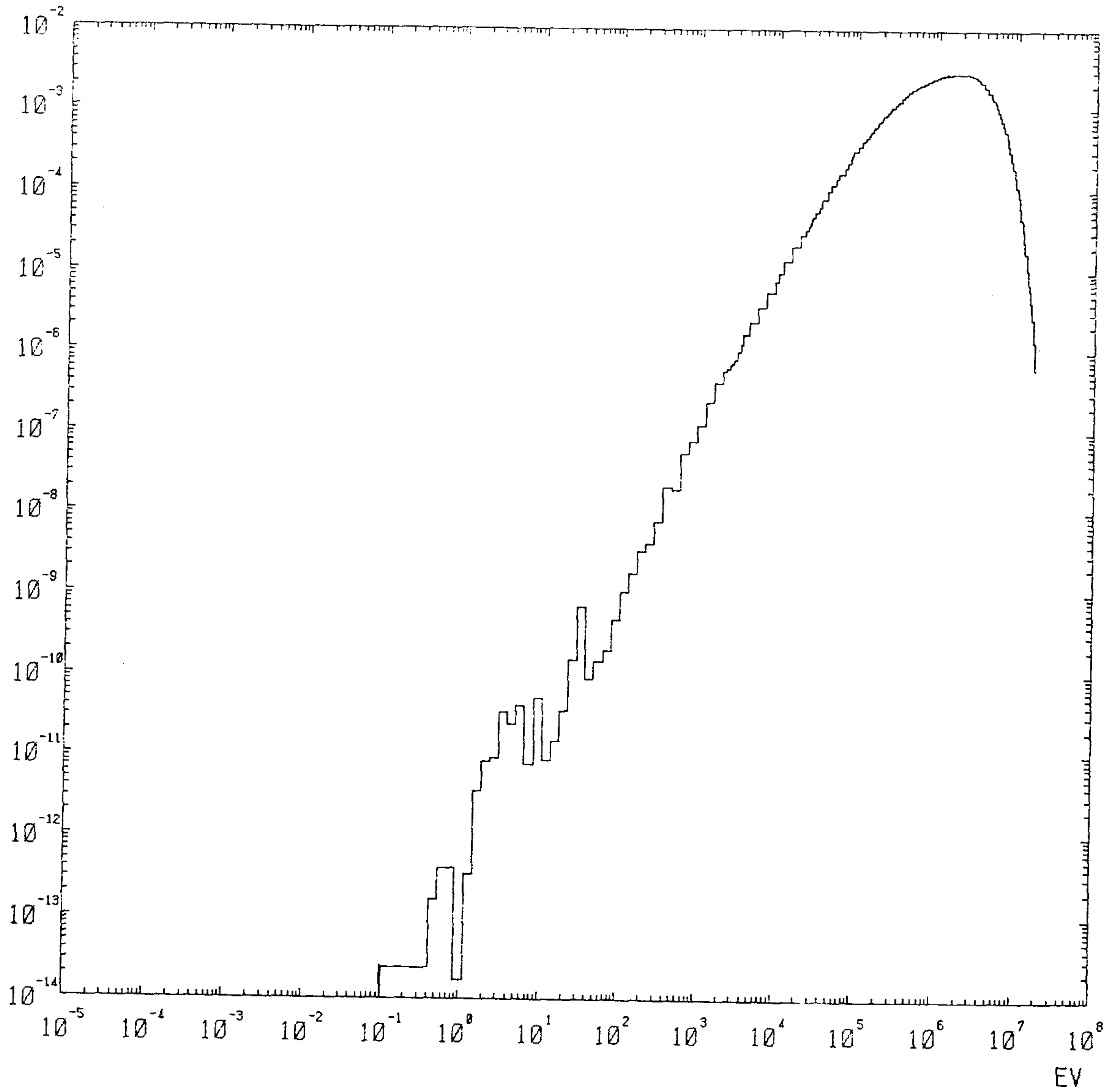


Fig. 3.13.1: Neutron Spectrum at Centre of JEZEBEL-Pu Assembly, Expressed per Unit of Lethargy, Given in Arbitrary Units, Calculated Using the VITAMIN-E Structured JEF-1 Based Library

3.14 Discussion of Results

Table 3.14.1 summarizes all results from Tables 3.1.1 - 3.13.1 for all Benchmark specifications considered. Main points from this table and from all calculations are:

1. JEF-1 results are comparable with those from ENDF/B-V evaluation. This validates JEF-1 data in the fast energy range. Eigenvalues are mostly predicted well within 10 mk and result to be generally more accurate in the computations based on the JEF-1 evaluation than in those based on ENDF/B-V. Larger discrepancies arise in the VERA experiments (k-eff = 0.985), where the spherical model without Buckling height correction seems to be a first approximation of the actual cylindrically shaped assemblies. Reaction rates and spectral indices at core centre are found to be in 10 % agreement with experiment and are predicted with similar accuracy by ENDF/B-V as well as by JEF-1 data files. 20 % discrepance by VERA experiments is rather a consequence of too low an estimate of its reactivity.

2. U-233 fission and total cross sections in the fast MeV spectrum range (see Figures 3.1-3) seem to be underestimated in the JEF-1 evaluation. This results in systematically too low reactivity of JEZEBEL-23 and FLATTOP-23 critical assemblies. Furthermore spectral indices of U-233 probes in remaining experiments are underestimated compared to ENDF/B-V. However, the same phenomenon affects probably ENDF/B-IV basic data as well (see Ref. 2).

3. Bad estimate of Co-59 capture rates in GODIVA seems to be rather due to an experimental error or to a printing mistake in Ref. 6 (compare Table 3.3.1 with Table 3.5.1), since both neutron spectra in GODIVA and in BIG TEN where these rates were measured are rather similar (compare Fig. 3.3.1 with Fig. 3.5.1).

4. The influence of the weighting spectrum on the determination of the fission spectrum χ is minor and results in less than 1 mk change of the eigenvalue (see Tables 3.3.1 and 3.12.1). This is because the initial weight function (see Fig. 2-1) is well representative for spectra of fast critical assemblies (compare Fig. 3.1.1 - 3.13.1 with Fig. 2.1).Moreover all spectra of fast critical assemblies are rather similar (see Figures 3.1.1 - 3.13.1) and resonances of fissionable materials lie below the important flux part. Iron resonances are well described in the VITAMIN-E group structure. These result in minor flux peaks at energies in the KeV range in VERA, ZPR and ZEBRA assemblies (see Figures 3.2.1, 3.10.1, 3.11.1 and 3.12.1). Moreover the use of S_{16} approximation in the transport calculations is suitable.

5. Results presented in this report are fully compatible and agree generally within 1 % with those from previous analysis based on diffusion theory /2/ in which NJOY system was used to process 71 neutron group JEF-1 cross section library. This is true in the case that diffusion results are corrected to transport values. These corrections were already performed for the eigenvalue in Ref. 2. Reaction rates are now modified according to the values reported in Ref. 4. Table 3.1.15 summarizes eigenvalues and principal reaction rates ratios in the VERA, ZEBRA and ZPR experiments.

Value	Experiment, Calculated/Experimental Values for ENDF/B-V, JEF-1						
	JEZEBEL	VERA-11A	ZEBRA-3	GODIVA	VERA-1B	ZPR-3-12	JEZEBEL-23
k-eff	1.0111	0.9884	1.0090	1.0028	0.9923	1.0061	-
	1.0095	0.9860	0.9953	0.9995	0.9847	0.9968	0.9620
CO2/C28	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
FO2/F28	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
NO2/N28	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
F23/F25	0.9867	1.0195	1.0104	0.9855	1.0537	1.0277	-
	0.9185	1.0060	0.9920	0.9515	1.0434	1.0192	-
F24/F25	-	-	1.1220	-	-	1.1675	-
	-	-	1.0051	-	-	1.0731	-
F26/F25	-	-	1.1475	-	1.3396	-	-
	-	-	1.0283	-	1.3187	-	-
C28/F25	-	-	-	-	0.9435	0.9659	-
	-	-	-	-	0.9443	1.0358	-
F28/F25	0.9167	1.1922	1.0282	1.0364	1.2331	1.0915	-
	0.9757	1.2208	0.9892	1.0595	1.2556	1.0872	0.9193
N28/F25	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
F37/F25	0.9891	1.2281	1.1176	1.0640	1.2850	-	-
	0.9634	1.2422	0.9453	1.0167	1.2187	-	0.9184
F49/F25	0.9724	1.1037	1.0092	0.9943	1.0813	1.0125	-
	0.9878	1.1186	1.0057	1.0076	1.0907	1.0098	-
F40/F25	-	1.1373	1.0885	-	1.2571	-	-
	-	1.1307	0.9828	-	1.2514	-	-

Value	Experiment, Calculated/Experimental Values for ENDF/B-V, JEF-1					
	BIG TEN	JEZEBEL-Pu	FLATTOP-25	FLATTOP-23	THOR	FLATTOP-Pu
k-eff	-	-	1.0149	-	-	1.0207
	1.0016	1.0024	0.9984	0.9766	0.9923	1.0054
CO2/C28	-	-	-	-	-	-
	-	-	-	-	1.2262	-
FO2/F28	-	-	-	-	-	-
	-	-	-	-	0.8777	-
NO2/N28	-	-	-	-	-	-
	-	-	-	-	1.0744	-
F23/F25	-	-	-	-	-	-
	0.9691	-	0.9476	-	-	-
F24/F25	-	-	-	-	-	-
	-	-	-	-	-	-
F26/F25	-	-	-	-	-	-
	-	-	-	-	-	-
C28/F25	-	-	-	-	-	-
	1.0145	-	-	-	0.8048	-
F28/F25	-	-	1.0383	-	-	0.9400
	1.0322	0.9811	1.0617	0.9178	0.9990	0.9844
N28/F25	-	-	-	-	-	-
	-	-	-	-	1.2245	-
F37/F25	-	-	1.0868	-	-	1.0143
	0.9487	0.9859	1.0305	0.9224	0.9635	0.9600
F49/F25	-	-	1.0007	-	-	-
	1.0032	-	1.0126	-	-	-
F40/F25	-	-	-	-	-	-
	-	-	-	-	-	-

Table 3.14.1: Summary of Important Performance Parameters from Tables 3.1.1 - 3.13.1 Related to All Critical Experiments

Table 3.1.15: Comparison between Ratios to Experiment of Eigenvalues and Spectral Indices in VERA-11A, VERA-1B, ZEBRA-3 and ZPR-3 12 Assemblies, Computed Using Diffusion and Transport Theory, and two Different JEF-1 Based Nuclear Data Libraries /2/.

	Transport VITAMIN-E (C/E)	Diffusion 71 Groups (C/E)	Diffusion 71 groups corrected (C/E)
VERA-11A			
k-eff	0.9860	0.9343	0.9850
F28/F25	1.2208	1.1738	1.2293
F49/F25	1.1186	1.0997	1.1110
F40/F25	1.1307	1.0923	1.1351
VERA-1B			
k-eff	0.9850	0.9592	0.9867
F28/F25	1.2556	1.2737	1.2753
F49/F25	1.0907	1.0891	1.0967
F40/F25	1.2514	1.2581	1.2665
C28/F25	0.9443	0.9278	0.9265
ZEBRA-3			
k-eff	0.9953	0.9786	0.9906
F28/F25	0.9892	1.0050	1.0047
F49/F25	1.0057	1.0035	1.0035
F40/F25	0.9828	0.9936	0.9928
ZPR-3 12			
k-eff	0.9968	0.9900	0.9990
F28/F25	1.0872	1.1023	1.1022
F49/F25	1.0098	1.0067	1.0067
C28/F25	1.0358	0.9744	0.9744

4 CONCLUSIONS AND RECOMMANDATIONS

A series of fast critical Benchmark assemblies were computed using the deterministic one dimensional transport code ONEDANT in spherical geometry , together with a multigroup VITAMIN-E structured multigroup cross section library based on the JEF-1 evaluation. Eigenvalue and reaction rates ratios were compared with experiment, with those from the ENDF/B-V basic files, and with previous studies performed at NEADB. From the analysis presented above some conclusions and recommandations can be reached.

1. The JEF-1 evaluation gives accurate results when compared with those from the ENDF/B-V files.

2. Eigenvalues agree generally well within 10 mk using both evaluations. In some cases, such as in GODIVA, JEZEBEL and FLATTOP, JEF-1 eigenvalues are more close to experiment.

3. Reaction rates agree within 10 % to experiment in both evaluations. Overestimate of fission of U-238 in VERA assemblies is rather due to the approximative simulation through the one dimensional model.

4. U-233 fission and total cross sections in the fast MeV energy range seem to be underestimated in the JEF-1 evaluation. A new evaluation should be undertaken for this isotope.

5. Corrected diffusion theory results are fully compatible with transport theory values, even if a lower number of groups is used (i.e. 71 versus 174).

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