IEC-90

STATUS OF THE JEF EVALUATED DATA LIBRARY

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I. INTRODUCTION

The Joint Evaluated File (JEF) is a collaborative project between the countries participating in the NEA Data Bank, e.g. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and United Kingdom. Mexico and South Korea are about to joint the NEA Data Bank.

The JEF project is managed by a Scientific Coordination Group (SCG) that meets at least annually. The technical achievements are reviewed at working group meetings, which are normally held twice a year. The following three major working groups exist:

- Data Evaluation
- Benchmark Testing
- Radioactive Decay and Fission Yield Data

A related group, called the NJOY User Group, has also been formed to discuss problems and possible solutions to data processing questions, concerning the NJOY code systems, which is widely used in the preparation of group data sets for the validation of JEF. The NJOY User Group normally meets in conjunction with the JEF Working Group meetings.

II. THE JEF-2.2 LIBRARY

The JEF-2 library comprises the general purpose file (tapes 1 to 9), the thermal scattering law file (tape 21), the radioactive decay data file (tape 22), the fission yield file (tape 24), and the photon interaction file (tape 25). The data are stored in the ENDF-6 format.

The second version of the library was released to the JEF group at the end of January 1992, with a subsequent general worldwide release decided in November 1992. The general purpose and the thermal scattering law files were available for distribution at that time, whereas the radioactive decay and fission yield were still being validated and were released in July 1993.

The JEF-2.2 data can be obtained by simple request, either from the NEA Data Bank, Paris, France, or from regional data centres, e.g. NNDC Brookhaven, USA, (for US and Canada) or IAEA Nuclear Data Section, Vienna, Austria (for non-OECD countries). These data centres have also direct on-line services for customers linked to computer networks, such as Internet.

III. VALIDATION OF THE JEF-2.2 DATA

An extensive programme of benchmark testing of the JEF-2.2 data have been undertaken during the last two years. The general purpose file has been validated both for thermal and fast reactor applications, as well as for many other special applications, such as radiation shielding including a special emphasis on the major structural materials. A large number of laboratories throughout Western Europe have been engaged in this data processing and validation phase. Of the main contributors could be mentioned: CEA Cadarache and CEA Saclay, France; IKE Stuttgart, Germany; IRI Delft and ECN Petten, Holland; ENEA Bologna, Italy; PSI Villingen, Switzerland; Studsvik, Sweden; and AEA Winfrith, UK. A separate paper describing the details of the benchmark testing of the JEF-2.2 library will be presented at this meeting[1], and only a few examples are given below.

A. Thermal Energy Benchmarks

The JEF-2.2 data have been validated in a wide range of thermal applications. The validation of the ^{235}U JEF-2 data using the newly agreed upon η energy shape are here mentioned as one example. Table 1 below shows the results from temperature coefficient calculations by H.

Tellier, CEA Saclay, France, compared to experimental results. It should be pointed out that when using a flat η for ^{235}U the difference between calculations and experiments, for the cases given in table 1, were of the order of -3 to -4 pcm/°C.

Experiments	(C-E)/C pcm/°C
KRITZ Plutonium (21 - 236 °C)	-0.2
KRITZ Uranium (20 - 248 °C)	-0.24
JAERI Uranium (20 - 80 °C)	-0.67
JAERI Plutonium (20 - 80 °C)	-0.46

Table 1 Temperature coefficient calculations using the JEF-2.2 η shape of ^{235}U

B. Major Structural Materials

A large effort has been devoted to the validation of the major structural materials, especially the Fe isotopes. Most of this work has been performed in very close collaboration with the EFF (European Fusion File) project, and common meetings have been held to coordinate the activities and to discuss the results.

One example out of the the many contributions in this field is the PCA-Replica validations performed by M. Pescarini, Italy. The results using the JEF-2 data will be published later in an ENEA report.[2] The code DOT-3.5E, with the weighted difference spatial discretisation model, was used in the calculations of the integral results from the threshold detectors presented in Figure 1 below. Calculations using the exponential model was also performed.

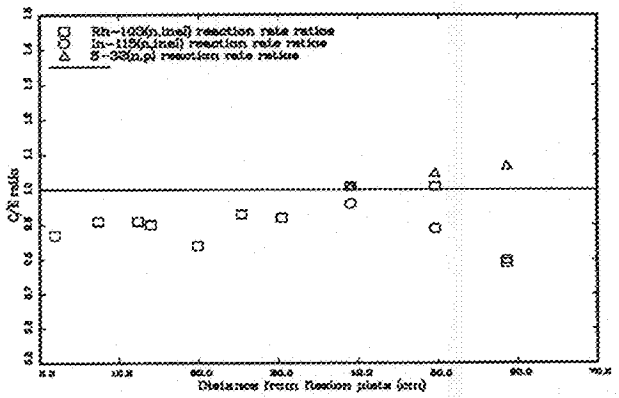

Figure 1 Results from threshold reaction rate ratios on the horisontal axis of the PCA-Replica shielding benchmark experiment

C. Calculational Benchmark

In order to investigate the influence of the choice of calculational model on the final validation results, the JEF group decided to conduct a simple three region PWR Uranium pin-cell benchmark, using the JEF-2.2 data. J. Rowlands, France, is coordinating this calculational exercise.

The benchmark was divided up into two parts, one without and one with leakage. The preliminary results from the case with zero leakage are given below in Table 2.[3] Eight different cases were proposed, covering various temperatures and cooling regions. The analysis of the results are still going on and follow up actions, such as further investigation of the methods used to obtain fission spectra, could be envisaged. The final results will be published later in 1994.

Preparatory work has been started on a subsequent Plutonium pin-cell benchmark.

Computer code (Establishment)	k_∞	Δk_∞ (pcm) (Rel. to MCNP)
MCNP (ECN Petten)	1.38952	
ECCO (CEA Cadarache)	1.38750	-202
ECCO (hyperfine) (CEA Cadarache)	1.38889	-63
APOLLO-2 (CEA Cadarache)	1.39015	+63
LWR-WIMS (AEA Winfrith)	1.38678	-274
SCALE-4.0 (IRI Delft)	1.38733	-219
PASC (ECN Petten)	1.38458	-494
CASMO (Studsvik)	1.38617	-335
KENO (IRI Delft)	1.3862	-330

Table 2 PWR pin-cell benchmark (zero leakage, 293°K) results

D. Decay Heat Applications

Among the special purpose libraries, a particular effort was devoted to the validation of the radioactive decay and fission yield data for decay heat applications. Participating laboratories in this testing phase were: CEA Saclay and CEA Cadarache, France and Nuclear Electric and British Nuclear Fuels (BNFL), UK. The results from the calculations using the JEF-2.2 libraries are summarised in the figure below. The details of this study are given in a separate paper, submitted to this conference.[4]

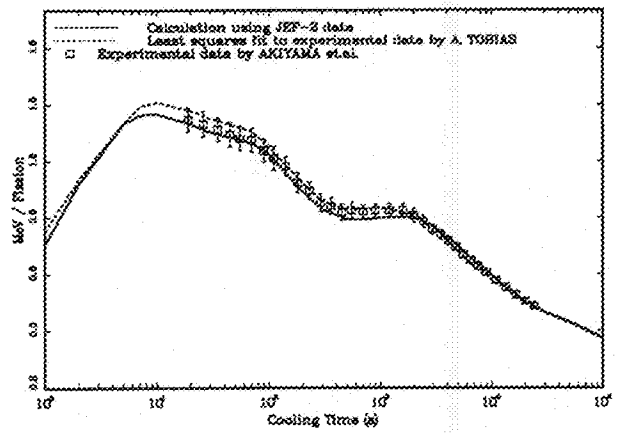

Figure 2 Calculation of the total decay heat from a ^{235}U fission pulse using JEF-2.2 data

E. Other Validation Efforts

Apart from the few examples given above, many other validation calculation of the JEF-2.2 data have been performed, covering a wide range of different applications. Some of these areas below will be covered in different contributions to this conference. The following non-exhaustive list gives some examples from various application regions:

- Fast reactor benchmarks, such as JEZEBEL, GODIVA, etc. (Many laboratories)
- CERES burp-up credit analysis for the DIMPLE reactor (AEA Winfrith)
- Thermal systems, such as the ORNL and TRX benchmark series (ECN Petten, CEA Saclay and others)
- Pu criticality benchmark analysis using the MONK6 code (AEA Winfrith)
- Graphite shielding benchmark analysis (AEA Winfrith)
- Validation of the STEK and ROSSENDORF experiments for structural materials and fission products. (CEA Cadarache; paper presented at this meeting)[5]
- Validation of ^{237}Np and Am-isotope data performance in transmutation systems. A typical result is the analysis of the SUPERFACT irradiation experiment in PHENIX, where pins containing Np and/or Am have been irradiated. C/E values are given in table 3.[7] (PSI Villingen; paper presented at this meeting[6] and CEA Cadarache (table 3))

Table 3 SUPERFACT experiments - Transmutation rates (%)

Isotope	**Np-237**	**Am-241**	
Type of pin	45% ^{237}Np	2% ^{241}Am	20% ^{241}Am
Measurement	27.0	27.2	32.0
Calculation (CEA methods + JEF-2 data)	27.5	27.3	31.6

- Neutron point heating and KERMA (ENEA Bologna and AEA Winfrith)

IV. DOCUMENTATION OF JEF

The main documentation of the JEF-2.2 general purpose library is being prepared at the NEA Data Bank. It will comprise two documents:

- one will be a publication containing an index of the content and the complete comment part (MF=1, MT=451) of each evaluation. It will also include a description of the history and organisation of the JEF project, and some useful references with regards to contact addresses and internal JEF working documents in the JEF/DOC series. As this publication will be too voluminous to widely distribute in paper form, it is planned to send it out in form of a PC computer code, with possibilities to selective local printing.
- the second will be a smaller report comprising an index of data types available for each isotope or element in the JEF-2.2 library. A major part of this work has already been done at ECN Petten.[8]

The NEA Data Bank has developed, in cooperation with the University of Birmingham, UK, CNRS Orsay, France, and BNFL, UK, a PC based computer code in order for users to have quick access to the JEF-2.2 data

and not having to learn the ENDF-6 format in which the original data are stored. This program is being presented in a separate contribution to this conference (figure 3).[9]

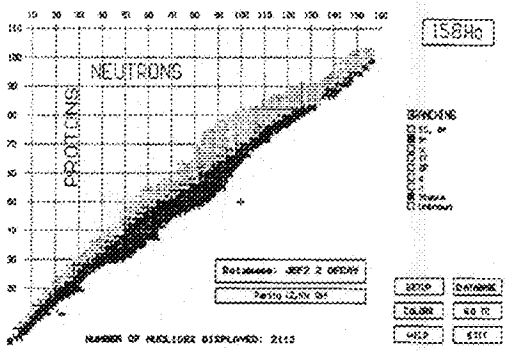

Figure 3 Main display of the chart of the nuclides in the PC program to visualise the JEF data.

One publication of the complete JEF-2.2 radioactive decay and fission yield data, comparing the main decay parameters with those of other evaluated data libraries and one comparing JEF-2.2 simple integral cross section data (maxwellian average cross sections, resonance integrals etc.) with other major evaluated data libraries will be issued in the near future.

The above mentioned publications are planned to be issued in 1994. It is also envisaged to publish a summary document of the complete validation of the JEF-2.2 library. This publication will be prepared as soon as the benchmark testing phase has been completed.

V. FUTURE DEVELOPMENT OF JEF

A. Development of JEF-3

At the meeting, in December 1993, of the JEF Scientific Coordination Group (SCG) it was decided that the JEF-2.2 general purpose library, released in January 1992, would not be further updated. Future work would be oriented towards long term improvements, leading to a validated JEF-3 library. The benchmark testing of the JEF-2.2 library has revealed some cases where improvements to the data would be welcome, and a list of isotopes concerned are maintained at the NEA Data Bank. The SCG once again stressed the importance of a close link to an active experimental programme for future work within the JEF project.

Initial discussions with the JEF group have identified the following main areas of activity for the development of a JEF-3 library:

- Structural Materials, Zr, Cr, Fe, Ni
  - Special effort on Fe isotopic evaluations.
  - The possibility of international cooperation on the evaluation of Cr and Ni data. New measurements of ^{58}Ni(n,α) data had been made at Geel.
  - Further work on Zr data to resolve inconsistencies between the isotopic and elemental data files would be undertaken.
- Major Actinides (^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu)
  - More work on ^{235}U capture needed.
  - Work on the ^{238}U inelastic cross section is being performed within the NEANSC Working Party on International Evaluation Cooperation (WPEC).
  - Work on Doppler broadening in UO_2 would also be desirable.
  - WPEC results will be available for the ^{239}Pu fission cross section, as well as new resonance parameter data by H. Derrien.
  - Feedback from PHENIX results indicated that a new evaluation was needed for ^{240}Pu. Proposals would be discussed in the framework of the WPEC.
  - New resonance parameter data were available for ^{241}Pu (H. Derrien) and would be later included in the JEF library. The possibility of a WPEC subgroup on ^{241}Pu would be investigated.
- Minor Actinides (^{237}Np, ^{241}Am, ^{243}Am, ^{233}U, ^{232}Th, ^{233}Pa)
  - The main interest is on ^{237}Np and ^{241}Am, and to a lesser extent ^{243}Am. A WPEC review of these data will be completed by June 1994. Discrepancies, in particular on ν values, between JEF-2 and ENDF/B-VI for ^{237}Np were reported by S. Pelloni. More measurements in the resonance region and for inelastic scattering were considered necessary for all three isotopes.
  - A new resonance parameter evaluation is available for ^{233}U (H. Derrien). Additional work on ^{232}Th and ^{233}Pa would be desirable.
  - It was considered to review the status of all minor actinides in JEF-2, and possibly complete with other available evaluation.
- Fission Products
  - Investigation of the inelastic cross sections of even-even fission product isotopes has been started. Measurements of inelastic scattering in

Pd are in progress at IRMM, Geel, and results of integral measurements were being analysed.

— New measurements on ^{99}Tc are being planned at Geel. The results from the CERES Integral Measurement Programme will be considered for JEF-3.

- Light Elements
  - — EFF data for Li, Be, Si, Al, Pb, and Mo isotopes should be considered for adoption for JEF-3.
  - — The present ^{16}O evaluation will be reviewed, as well as the data for C.
  - — A new evaluation of ^{23}Na (Moxon and Sowerby) showed large discrepancies with earlier work. Further measurements would be desirable.
- Burnable Poisons and Absorbers
  - — A list of burnable poisons and absorbers where further work would be needed has been compiled. It includes Gd, Hf, Er, Eu, Ag, In, Dy, Cd and B isotopes. Future CERES experiments should provide some information on ^{155}Gd, ^{151,153}Eu. ENEA Bologna would possibly provide an evaluation for Hf, as well as investigating problems with Er and Eu found by Studsvik. A general review of the remaining elements would be discussed at the next WPEC meeting.

The NEA Data Bank has designed a new data base system for the maintenance of the JEF library, based on quality assurance requirements. The new system would, for example, not accept any corrections or updates to the data without accompanying proper justification for and documentation of the changes. The new system should be operational for the maintenance of the JEF-3 development.

B. Collaboration with the EFF project

The continued collaboration with JEF and EFF projects has been thoroughly discussed. The EFF and the related European Activation File (EAF) programmes have been re-oriented towards the short-term needs of the ITER project, although these programmes also consider long-term European needs. The joint support of ITER and the C.E.C. combined with the excellent European infrastructure provides a good basis for further work in evaluation, processing and benchmarking of nuclear data for fusion design calculations.

The EFF-2 files are essentially complete, needing only minor changes before release. The pointwise library was frozen in February 1994 and the processed libraries followed in March 1994. The validation phase of the EFF data would then follow. It was planned to have a new Fe evaluation (EFF-3) ready by the end of 1994.

The earlier proposed merging of the EFF/EAF and JEF libraries, leading to a joint library, known as JEFF-3, remained a possibility, and would be considered in the timescale of the JEF-3 and EFF-3 releases.

VI. REFERENCES

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8. Cai Chonghai, "Directory for using JEF-2.2 evaluation library", *Private communication from H. Gruppelaar*
9. M. Konieczny et. al., "A PC program to display the JEF evaluated data", *Contribution to this Conference*