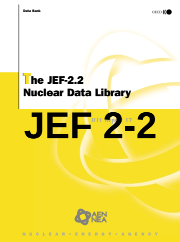

JEFF Working Group on Fission Product Cross-sections.

Summary Record of the Meeting held on Monday 15 December 1997.

Introduction.

H Gruppelaar opened the meeting by summarising the June meeting of the Working Group (JEF/DOC-726) and indicating progress made since the meeting which formed the basis of the agenda. A draft version of ECN-R-97-011 "Status of Pseudo Fission Product Cross Sections for Fast Reactors" had been issued. A document commenting on an earlier draft of this report had been received from Japan and the comments had been partially incorporated in the latest version. Both documents had recently been distributed. A paper, by N Gulliford, on the production of a similar pseudo fission product for thermal reactors, was distributed at the meeting. G Rimpault would report on fission product calculations for fast reactors. A paper by H Weigmann on measurement of long-lived radioactive fission products was issued.

At the June meeting it had been agreed that the basis of the selection of evaluations for JEFF-3 should be JEF-2.2, with the data for the most important fission products (in particular the isotopes selected for study in the CERES programme) being reexamined, and improved if it was considered desirable to do so. Another proposed aim was consistency with the EAF library. Codes such as ORIGEN and FISPACT, which are used for inventory calculations, should preferably use data which is consistent with that used for neutronics calculations. On the basis of the discussions at the present meeting a work programme was to be devised for the study of the selected most important fission products.

Status of Pseudo Fission Product Cross Sections for Fast Reactors.

Sub-Group 17 of the Working Party on International Evaluation Co-operation had completed the analysis of fission product data for Fast Reactors. Data from JEF-2.2, JENDL-3.2, EAF-4.2, and the three Obninsk libraries, BROND-2 (limited set of isotopes), FONDL-2.1 and ADL-3 had been used to generate a pseudo fission product by weighting individual fission product data with defined Pu-239 yields. A weighting spectrum, generated using the ECCO code, and modelling the fuel region of a fast reactor had been supplied. However, most of the data sets were first produced in a multigroup form using different weighting spectra and some were condensed to 1 group using a different fast reactor spectrum. Tables compared one-group pseudo fission product cross sections for all reactions. Similar tables were available for the individual fission products ordered by contribution to absorption. The overall analysis indicated a variation of ~6% in lumped pseudo fission product capture and ~9% in inelastic cross sections. These gave rise to a spread in pseudo fission product worth of ~5.5%. The larger differences for (n,2n) and other threshold reactions were noted, these being very sensitive to the weighting spectrum shape. If it can be assumed that the above ranges in value reflect the uncertainties the present status of lumped fission product cross sections for fast reactors is satisfactory, although some improvements are possible, as indicated in the report. Issue of the draft report in July resulted in detailed comment from Japan and some of the modifications proposed by the Japanese had already been incorporated in the current draft. Certain interrelated files would be removed from the analysis.

JENDL-3.2 includes a more recent choice of resonance parameters and has made use of more modern measurements to derive the optical model parameters. There were two criticisms of

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the JENDL evaluations. One was that by extending the resolved resonance ranges to higher energies there was more danger of missing resonances and a consequent underestimation of the cross-sections in the higher energy part of the ranges. The second was that a single optical model had been used for the whole fission product range whereas different models had been used in JEF for different mass ranges. The calculation of inelastic scattering cross-sections in nuclei with masses near 100 might be a problem and is being reinvestigated.

Analysis of the STEK experiments.

The Japanese reply includes an analysis of some of the STEK fast reactor reactivity worth measurements and a comparison with the ratio of JENDL-3.2 to JEF-2.2. Studies at Petten give different results from those in the Japanese report. A separate JEF-2.2 analysis of the STEK experiments is being carried out at by A Meister at Cadarache.

● G Rimpault agreed to summarise the calculations. He noted in particular the difference between JENDL-3.2 and JEF-2.2 for Sm-151 (ratio 0.62) for which there are STEK calculated values.

Thermal reactor lumped fission product worth comparison and conclusions from the CERES experiments.

A scoping study to generate lumped fission product worths, from JEF-2.2 and JENDL-3.2, for thermal reactors was presented by C Dean on behalf of N T Gulliford and D Hanlon. The paper "Worths of Thermal Reactor Fission Products" (JEF/.DOC-730) describes the use of compositions generated from a WIMS burnup (to 27.35 GWD/te) calculation to model a 3.1% enriched PWR pincell from phase 1B of the NEA Burnup Credit Benchmark. A 14×14 clean fuelled cluster model of the Calvert Cliffs reactor provided fluxes and adjoints in the 172 group XMAS scheme. 82 fission products were modelled following studies indicating these generated 99% of absorption at all burn-ups for PWRs and AGRs with UO_2 and MOX fuel. JEFPCv2 provided capture cross sections from JEF-2.2 and JENDL-3.2. EXCEL spreadsheets were used to generate worths of each fission product based on JEF-2.2 and JENDL-3.2 data. These were compared and ordered by contribution. They were summed to form lumped fission product worths. The difference in overall worth between JEF-2.2 and JENDL-3.2 was less than 1%.

A study presented at the June 1996 JEF meeting (JEF/DOC-732) had shown the effect of using JENDL-3.2 instead of JEF-2.2 data for the leading CERES fission products. This had indicated little difference for Eu-153 whereas the scoping study showed 4.38% differences. Hence study was restricted to 3 nuclides with differences greater than 5%. JEFPCv2 was used to graph the capture cross sections of Cs-133, Sm-152 and Mo-95. Differences were seen in the lowest energy resonances of each nuclide which probably accounted for the main swing between JEF-2.2 and JENDL-3.2. From this it was suggested Sm-152 and Mo-95 evaluations be taken from JEF-2.2 and Cs-133 from JENDL-3.2. It was noted that the earlier proposal had been to adopt the EFF evaluations for the natural isotopes of Mo, but these include the JENDL-3.2 evaluations in the thermal and resonance region. This proposal should now be reconsidered. It was suggested Eu-153 data needed more study. The meeting welcomed these indications on the choice of evaluations but suggested further study be made by a nominated evaluator before adopting the recommendations.

A Santamarina reported that the treatment of resonance shielding in the CEA analysis of fission product reactivity worth measurements made in MINERVE had been improved. The results indicated that JEF-2.2 underestimated Sm-149 and Nd-143 results by ~5%. These results are now in line with UK analysis. For Eu-153 he considered that the JENDL-3.2 evaluation gave the best results. A Santamarina agreed to provide a table summarising the CERES fission product worth measurements made in DIMPLE and MINERVE and the Cadarache and Winfrith analyses.

Fast reactor burn-up/reactivity swing measurements.

G Rimpault reported preliminary results of the fast reactor fission product calculations being made at Cadarache. These are to be published by the next JEFF meeting. JEF-2.2 was found to predict the worth of the burn-up/reactivity swing in Super-Phenix to within 5%, the uncertainty on the measurement being ± 8%. Using the unadjusted JEF-2.2 library gave a C/E value of 0.95 ± 8% and the adjusted library gave 1.05 ± 8%, the main difference arising from adjustments to the Pu-239 data. (The fission product cross-sections have not been adjusted). He noted that 80% of the reactivity change in the fuel cycle was due to fission product absorption. One source of uncertainty is the fission Q value used in the study (a value of 206 MeV having been adopted for Pu-239). E Fort is producing a new evaluation. The heterogeneity correction was also large, ~7%. The study was unlikely to provide a test of the relative merits of the JEF-2.2 and JENDL-3.2 data, the uncertainty being too large. He further noted resonance shielding was important. The importance of fission products was much less for Phenix where 80% of the reactivity swing was due to changes in the heavy nuclide composition. Currently he was investigating the impact of using JENDL-3.2 Sm-151 data, after seeing that ECN-97-011 page 22 indicated a reduction in overall absorption from 3.3618 to 2.1808 barns.

G Rimpault added that for studies of radiotoxicity three more fission products must be added to the set treated in the reactivity worth study.

Measurements on long-lived radioactive Fission Products.

H Weigmann presented "Remarks on Measurements on Long-lived Radioactive Fission Products" (JEF/DOC-727). The paper notes the need to know the capture cross sections of candidate fission products for incineration to 5-10%. It notes difficulties in obtaining samples for measurement from industrialised waste streams and describes some difficulties in handling including requirements for shielding modifications. It then describes the current status of experimental data for the following long-lived fission products:- Se-79, Zr-93, Tc-99, Sn-126, I-129, Cs-135, Sm-147, and Sm-151. H Weigmann also noted plans to measure Cs- 133 data at Geel in the next 6 months.

PROPOSED WORK PROGRAMME.

In order to start assembly of the JEFF-3 Starter File by the NEA Data Bank, it had been agreed that the JEF-2.2 fission product evaluations should be adopted.

It was also proposed that a review, by nominated evaluators, of up to 24 of the most important fission products should be carried out. This is expected to change the source evaluations from

JEF-2.2 to JENDL-3.2 for a few of these fission products. New evaluation will be incorporated into JEFF-3 for certain fission products e.g. Tc-99.

The proposed reviews will:-

(a) examine the 2200m/s cross sections and resonance integrals, and the first 5 or so resonances in detail; where necessary (and if possible) incorporate negative energy resonances so as to remove background cross sections,
(b) consider the overall resolved resonance range; if there are missing resonances consider ways of adding a missing resonance contribution or of reducing the upper energy if this is not possible,
(c) include unresolved resonance ranges (with suitable mean parameters) to allow resonance self shielding to be treated, which has been noted as being important for fast reactors; the high energy data should connect smoothly to the resonance range.
(d) when considering studies of inelastic scattering, concentrate on low lying states with thresholds below ~1.5MeV,
(e) check on consistency with the data in EAF97.

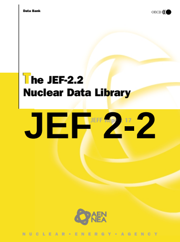
The list of possible reviewers was considered and the present proposals are:-

Isotope	Suggested Expert
Mo-95	(none allocated)
Tc-99	H Gruppelaar (Netherlands), C Raepsaet (France), D MacMahon (UK)
Rh-103	E Menapace (Italy), C Raepsaet(France)
Ag-109	(none allocated)
Cs-133	M Moxon (UK
Nd-143, 145	A Santamarina (France)
Sm-147, 149, 152	D MacMahon (UK)
Eu-153	M Moxon (UK)
Gd-155	D Watson (UK), E Menapace (Italy)

The UK contribution is subject to confirmation of industry support. E Menapace (Italy) noted he would be unable to review Mo-95, but would be able to consider fission products which were also absorbers (Eu + Gd isotopes).

List of Participants.

C. Dean	AEAT Winfrith	United Kingdom
V Gressier	CEN Saclay/ Geel	France
H Gruppelaar	ECN Petten	The Netherlands
Gunsing	CEN Saclay/ Geel	France
R Jacqmin	CEN Cadarache	France
Y Kopecki	ECN Petten	The Netherlands
W Mannhart	P T B Braunschweig	Germany
R Mills	BNFL Sellafield	United Kingdom
C Mounier	CEN Saclay	France
Mme C Raepsaet	CEN Saclay	France
G Rimpault	CEN Cadarache	France



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J Rowlands	(CEA consultant)	
A Santamarina	CEN Cadarache	France
H Weigmann	IRMM Geel	Belgium