3. SPECIALISTS' MEETING ON FISSION-PRODUCT CROSS SECTIONS, 18 JUNE 1997

A major aim was to review the current status of the neutron cross section data for the important fission products. Prior to this assessment, the status of an on-going comparison of pseudo fission- product cross sections from JENDL-3.2 and JEF-2.2 for fast reactors was described by Gruppelaar et al. Sub Group 17 (SG17) of the Working Party on International Evaluation Co-operation is conducting this benchmarking exercise under the auspices of the Nuclear Science Committee of the NEA. Several parameters have been compared, and it was concluded that data processing influences the capture cross section by 1% and the inelastic scattering cross section by 2%. The reactivity worth of the lumped fission product is dominated by the capture reaction, to give a spread in the total reactivity worth of only 5.5%. There is a trend for JENDL-3.2 cross sections to be smaller than those from JEF-2.2 for all reactions. One-group capture and inelastic scattering cross sections of most of the important individual fission products differ by less than 10%.

A similar exercise has not been performed for thermal reactors. A pseudo fission product would have rather different cross sections from that for a fast reactor due to differing overall yields from fission and differing daughter product contribution from neutron capture. Gulliford presented a reactivity comparison showing how well a WIMS calculation, with JEF-2.2 data, predicted measurements as a function of irradiation up to 60GWd/t. Very good prediction was achieved at the 5 irradiation points in the two assemblies. These were part of phase 1 of the CERES burnup credit programme. Assembly 1 highlighted fission events, whereas assembly II was sensitive to both fission and absorption. The latter results seemed to indicate JEF-2.2 predicted overall fission product absorption adequately. However, these calculations were dissimilar to those for fast reactors. Gulliford agreed to attempt a study similar to that of SG17 but for thermal reactors.

JEFF-3 requirements were discussed in terms of the paper of Rowlands (JEF/DOC-664), which notes the main choice is between JENDL-3.2 evaluations and those of JEF-2.2 (mainly European improvements to ENDF/B-V files which have remained unchanged in ENDF/B-VI). Rowlands' paper includes a summary of Gulliford's integral results from the CERES thermal reactor burnup credit programme. These data were presented in December 1996, but the table has been extended to compare thermal cross sections and resonance integrals in JEF-2.2 and JENDL-3.2.

The CERES programme used UK and French depletion codes to select the most important fission products, in terms of contribution to fission product worth in practical thermal reactor irradiated fuels. Gulliford presented an overhead listing the UK prediction of the top 24 nuclides, which range from Gd-155 contributing ~18% down to Gd-157 contributing 0.4% worth for typical irradiated thermal reactor.

After comparison of similar lists with the CEA and removing gaseous fission products, fuel samples doped in different fission products were manufactured and irradiated in experimental cores within the DIMPLE reactor at Winfrith and the MINERVE reactor at Cadarache. DIMPLE Assembly II and MINERVE R1-UO_2 are most representative of practical PWRs. Measurements of each fission product worth in the two experiments are now generally in good agreement (except for Tc-99).

Santamarina et al compared (in JEF/DOC-679) their MINERVE experimental data with JEF-2.2 predictions of fission product worth for 12 important fission products. Improved agreement is linked with using 172 rather than 99 groups, and adopting better representation of the important thermal resonances. Their results for dominantly-resonant fission products were poor due to lack of resonance shielding representation, which is now known to be necessary because the abundance of each fission product in the sample is up to 50 times that seen in reactor irradiated fuel. Among the thermally absorbing fission products they noted JEF-2.2 data predict worths in agreement with experiment for Ag-109, Nd-145, Sm-147, Sm-152 and Gd-155; JEF-2.2 under-predicts the worth of Nd-143 and Sm-149 by ~6% .

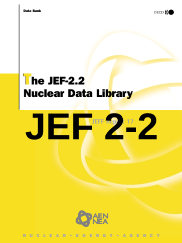
Gulliford had included resonance shielding effects in his analysis of both DIMPLE and MINERVE. He concurs with Santamarina's conclusions for thermally-absorbing fission products. Of the 12 isotopes, the most discrepant JEF-2.2 predictions (6-12%) are for Mo-95, Rh-103, Cs-133 and Eu-153. Gulliford's results using ENDF/B-VI are almost always worse, indicating the main choice for JEFF-3 is between JEF-2.2 and JENDL-3.2. He highlighted an important exception in the Eu-154 cross section leading to Gd-155, and also noted that the Nd-143 worths are well predicted with ENDF/B-V.

Gulliford predicted the effects of moving to JENDL-3.2 from JEF-2.2 from an assessment study using JEF-PC. For seven of the 12 isotopes there is no significant change. Use of JENDL leads to poorer predictions for Sm-152, Nd-145 and Mo-95, but better for Cs-133 (Tc-99 showed conflicting experimental results).

There was general discussion about sources of evaluated and measured data for fission products. New resolved resonance evaluations by Moxon for Eu-153 and Cs-133 (funded by BNFL) were noted. Sm isotopes were being evaluated by MacMahon with IMC support, and Gd studies by Watson et al was being funded by the HSE. The meeting hoped these UK evaluators could help review the appropriate isotopes; similar contributions were requested from other European evaluators.

The group noted that EAF-97 was to be recommended for the JEFF-3 activation file, and contained cross sections for many fission products. Consistency between the general purpose JEFF-3 and the activation file should be sought.

The meeting concluded that any attempts to improve the accuracy and quality of the data for fission-product cross sections should be focused through appropriate experts on the isotopes in the table on the next page.



Isotope	Suggested Expert
Mo-95	Manapace (Italy)
Tc-99	Gruppelaar (Netherlands), Raepseat(France), MacMahon (UK)+
Rh-103	Manapace (Italy)
Ag-109	(none allocated)*
Cs-133	Moxon (UK)
Nd-143, 145	Santamarina (France)
Sm-147, 149, 152	MacMahon (UK)
Eu-153	Moxon (UK)
Gd-155	Watson (UK)

+ MacMahon's name was added at the SCG meeting when Edens noted he was currently evaluating data for this nuclide.
* While the thermal cross sections and resonance integrals from different evaluations are very similar, the comments do not indicate that they contain copied data.

Developments in this area will continue to be monitored by Gulliford, Gruppelaar and Reffo.

A working plan was devised as follows:

1. The NEA will prepare review kits (as in the QA plan), and distribute to monitors by September 1997.
2. Feedback will be provided to the main JEF Working Group by December 1997.
3. The main working group will finalise the evaluation plans for the starter file by June 1998.
4. Sub-group 17 will discuss the choice and try to understand systematic differences between JENDL-3.2 and JEF-2.2 seen for fast reactor pseudo fission products.
5. Sub-group 17 will discuss the issue of how to improve cross section evaluations for some unstable fission products.
6. The main working group should be asked to consider any inconsistency between EAF-97 and JEFF-3 proposed starter files.
7. The main working group should be asked to determine the next most important set of fission product isotopes to review.