STATUS OF THE JEF PROJECT - MAY 1996

1. INTRODUCTION.

The JEF Project continues to hold meetings every 6 months, having joint sessions with the EFF Project on evaluation work and benchmark studies of joint interest. The last meeting of the JEF Working Group on Benchmark Testing, Data Processing and Evaluations was held at the NEA Data Bank, Paris, on 15 - 16 January (JEF/DOC-577) and the last meeting of the JEF Scientific Coordination Group was held in June 1995.

The plan is now for the JEF and EFF projects to cooperate to produce a single library, JEFF-3, and work has already begun to define the contents of this library and to carry out some benchmarking studies on the proposed files. Assembly of JEFF-3.0 will start this summer, following the JEF and EFF Meetings in July at which the contents of the "starter file" will be defined.

Benchmarking studies of JEF-2.2 continue. Work at Cadarache has the aim of defining a library of adjusted data and is now reaching a final version.

The First Phase Quality Assurance procedures have now been established and these will be used in the development of the JEFF-3 library.

2. PLANS FOR JEFF-3

The first version of the cross-section library JEFF-3.0 (the starter file) will consist of JEF-2.2 but with the evaluations in EFF in general replacing the corresponding evaluations in JEF. This is because the materials in EFF are a subset of those in JEF-2.2 and they have been evaluated more recently or are a more recent selection of the data in other libraries (in particular ENDF/B-VI or JENDL-3 in place of the B-V or JENDL-2 files adopted in JEF-2.2). The materials involved are listed in Tables 1 and 2.

It is also planned to incorporate the recently completed resonance region analyses for the actinide isotopes by Derrien for U-233 and Pu-241 (already incorporated in JENDL-3) and by Derrien and Bouland for Pu-240 together with the new resonance region evaluation for Fe-56 by Froehner, combined with the EFF-3 file. This will include covariance data which takes account of systematic errors. The adoption of the new evaluation for U-235, by Derrien and Leal will be discussed at the International Evaluation Cooperation meeting. Following a review of the JEF-2.2 evaluation, some minor modifications are proposed to the Am-241 evaluation: the inclusion of a missing resonance at 38.83 eV and the reduction of the neutron width of the resonance at 1.27 eV by 4%. However, these changes do not resolve the discrepancies with the integral measurements of the resonance region capture.

Changes will only be made if they are considered to be required. If an evaluation performs satisfactorily, as shown, for example, by the benchmarking studies, it will not be changed.

The additional developments which are currently being reviewed include the following:

- the addition of evaluations present in other libraries but absent from EFF/JEF (e.g. silicon and erbium isotopes),

the addition of missing data (such as photon production and fission energy release, which are not given in JEF-2.2 for many materials) by adopting the values from other evaluations (primarily ENDF/B-VI). A problem is the consistency of the photon production data and the inelastic scattering data and in some cases it might be preferable to adopt the inelastic scattering data also, or even the whole file.

the updating of the evaluations which have been adopted in JEF-2.2 from other libraries by later versions from the same library (i.e. replacing ENDF/B-IV and B-V evaluations with B-VI evaluations and JENDL-2 by JENDL-3), provided that the change is considered necessary,

the replacement of some evaluations by more recent evaluations from different libraries (e.g. replacing some ENDF/B-V evaluations adopted in JEF-2.2 by JENDL-3 evaluations), again provided that the change is judged to be necessary

Thermal scattering data for UO_2 is available in ENDF/B and should be adopted in JEFF-3 (together with any other thermal scattering data absent from JEF).

Correction of discrepant data and clarification of ambiguous data.
Some of the six time group delayed neutron data in the cross-section files are inconsistent. The inconsistency is between the decay constants and the relative yields. The adoption of Tuttle's data has been proposed.

The average parameters which specify the unresolved resonance region data for Pu-239 have sometimes been misinterpreted. This is because non-physical average parameters were chosen to reproduce the structure (the resonance form still being almost resolved in the lower energy part of the unresolved resonance region). It is proposed that the infinite dilution cross-sections should be incorporated in the file, together with the average resonance parameters, so as to avoid this possibility of misinterpretation. Revised average parameters corresponding to the new resolved region analyses are also required.

A new fission yield library has been produced by Mills (BNFL Sellafield) and is currently undergoing tests prior to its adoption. Work is also in progress to improve the radioactive decay data. Nichols (Harwell), Storrer (Cadarache) and Blachot (Grenoble) are engaged on this work. Storrer is also working with the Nuclear Physics Department of Uppsala University (Rudstam and Fogelberg) on the measurement and analysis of yield and decay data.

Plans for new evaluations include the use of GNASH to produce a revised evaluation for Pu-239. Updates are planned to Pu-240, Pu-241 Np-237 and Am-241. A consistent evaluation of the data for ν, Q, TKE and E_γ in fission is also planned.

Evaluation requirements must be reviewed in the light of effort available world-wide. The data adjustment studies, and the fission product benchmark intercomparisons, will give some guidance on requirements. There are requirements for improved structural material data, Fe, Cr, Ni and Zr; alternative absorber materials, such as erbium and those associated with burnup credit. In France there are requirements for data for plutonium burning fast reactors (with blankets removed and with fuel diluents) and for actinide and fission product incineration. There are also requirements for improved sodium data and for the U-233-thorium cycle.

3. BENCHMARK CALCULATIONS.

Several methods-related studies are in progress.

The pin cell benchmark studies had shown large discrepancies for the cases with leakage (represented by a buckling). Because of the absence of a continuous energy Monte Carlo method capable of treating such cases a finite reactor model has been proposed for intercomparison studies, the DIMPLE S01A assembly. Measured bucklings are also available for this core. This has been calculated using MCNP and deterministic methods. The purpose is to evaluate the accuracy of methods used for treating leakage. The JEF-2.2 MCNP calculations are found to be consistent with the measured values apart from the value of F8/F5 for which there is a 10% discrepancy. However, the measured value is suspect because it is inconsistent with other measurements. Calculations have also been made using ENDF/B-VI giving a k_{eff} value about 300 pcm lower.

The GODIVA and JEZEBEL intercomparisons have shown a deficiency in one of the methods which was giving a high value for GODIVA. The problem was partly due to the neglect of the anisotropy of inelastic scattering and (n,xn). Other differences were due to the methods used to derive the incident neutron spectrum averaged fission spectra. However, some differences remain to be resolved.

Intercomparison calculations for nitrate solutions have shown a problem in the hyperfine group data used in the MONK-7 Monte Carlo code. In fact, the group structure was not fine below 0.025 eV and an inappropriate weighting spectrum was being used. A finer group structure and a better weighting spectrum are now being used. Consistency is found between the APOLLO-2 deterministic calculations and the TRIMARAN-2 group Monte Carlo methods.

The plutonium nitrate solutions are also being studied to investigate a possible dependence of the k_{eff} (C-E) values on the Pu-240 content, with the objective of identifying possible discrepancies in the Pu-240 data. Studies using the new resonance region evaluation of Bouland and Derrien will also be made to study the effects of using this evaluation.

MCNP calculations have been made using both JEF-2.2 and ENDF/B-VI.2 for BWR simulated criticality experiments. Eigenvalue and fission rate distribution measurements are well predicted using both data sets.

Studies to investigate the new U-235 resonance region evaluation of Derrien and Leal are at an early stage. A number of calculations have been made but these are not sufficiently sensitive to the region where the changes have been made. In particular, irradiated fuel experiments still need to be analysed.

Several studies have been made comparing the results obtained using different data sets. A study has been made for the MASURCA CIRANO programme Assemblies ZONA2, ZONA3. There is a problem in calculating the fission rate distribution in the steel reflector region. However, the use of different data sets, nor the use of Monte Carlo methods, has not improved the results.

Studies using different data sets in MCNP give some differences which are probably due to the absence of a treatment of resonance shielding in unresolved resonance regions. This has a bigger effect for the older data sets such as ENDF/B-V.

4. NJOY

It is the intention to adopt NJOY 94-10 as standard in the JEF Project if the verification tests now in progress prove satisfactory.

5. COUNTRIES USING JEF-2.2

Data sets derived from JEF-2.2 are now in use in Britain, France, Germany, Italy, The Netherlands, Slovenia, South Korea, Sweden, Switzerland. The nuclear industries in several countries, notably Britain and France are also committed to adopting JEF-2.2.

6. QUALITY ASSURANCE

Draft Quality Assurance procedures were produced last Autumn. These were reviewed by UK members in the first instance and a revised draft produced for the January JEF Meeting. Some further revisions have been proposed and a final version of the Phase 1 Q.A. procedures will be presented to the JEF Meeting in July for final approval. An ORACLE Data Base will be used for the assembly of JEF-3 library.

Ph. F. and J.L.R. June 1996.

TABLE 1.

EFF-2.4 EVALUATIONS TO BE ADOPTED IN JEFF-3.

The EFF evaluations which differ from those in JEF-2.2 are the following:

	JEF-2.2 evaluation
Li-7	EFF-1 + ECN revisions
Be-9	EFF-1 + ECN revisions
Al-27	EFF-1 + ECN revisions
Si-28	Si-nat; EFF-1 + revisions
Cr 52*	ENEA + thermal revisions
Fe-56*	Froehner (earlier eval.)
Ni-58	ENDF/B-VI
Ni-59 (ENDF/B-VI)	ECN
Ni-60	ENDF/B-VI
Mo-isotopes	(B-V; JENDL-H; ENEA/CEA)
Pb-nat	EFF-1 + revisions.

*New EFF-3 evaluations to be adopted

V	ENDF/B-IV
Fe-56	

*EFF-3 work in progress

Cr-52 (IRK+Bologna)

EFF-3 work planned

Revisions to Li-7 and Be-9; (IRK)

POSSIBLE PROBLEMS IN ADOPTING EFF EVALUATIONS.

In EFF the emphasis has been on high energy data (MeV energies and high keV energies). The thermal and resonance region data for Cr isotopes and for Ni-58 and 60 might not be the best evaluations available.

The new evaluation which is being undertaken for Cr-52 at IKE and Bologna should include the resonance region reanalysis now in progress at Cadarache.

In the past there have been processing problems associated with the use in EFF of combined reaction data (combining elastic, inelastic and (n,xn)). IKE Vienna have said that they will produce data for the separate reactions for those cases which still have data in this form.

TABLE 2.

EVALUATIONS ADOPTED IN EFF-2.4 FROM OTHER LIBRARIES, WHICH DIFFER FROM THE JEF-2.2 CHOICE.

(In most cases more recent evaluations have been adopted in EFF-2.4).

EFF-2.4 Tape series 200.

		JEF-2.2 evaluation
Tj-nat	JENDL-3	BRC
V*	ENDF/B-VI	ENDF/B-IV
Mn-55	ENDF/B-VI	ENDF/B-IV +
Co-59	ENDF/B-VI	ENDF/B-IV +
Cu-63	ENDF/B-VI	Cu nat ENDF/B-IV
Cu-65	ENDF/B-VI	" "
Nb-93	ENDF/B-VI	ENDF/B-V+
I-113	JENDL-3	ENDF/B V+
I-115	JENDL-3	ENDF/B-V+
Ba-130	JENDL-3	-(no data)
Ba-132	JENDL-3	-(no data)
Ba-138	ENDF/B-VI	FNFA/CEA
Ta-181	ENDF/B-VI	ENDF/B-IV+

EFF-2.4 Tape series 300.

C-nat	ENDF/B-VI	ENDF/B-V+
N-14	ENDF/B-VI	ENDF/B-IV
N-15	ENDF/B-VI	JENDL-3+
Mg-nat	JENDL 3	ENDF/B-IV
P-31	ENDF/B-VI	JENDL-3+
S-nat	ENDF/B-VI	isotopes - JENDL-3 *
Ca-nat	JENDL-3	ENDF/B-IV
Sn-isotopes	JENDL-3	ENDF/B-V+; RCN-2
W-nat	JENDL-3	isotopes ENDF/B-IV+
Re-185	ENDF/B-VI	ENDF/B-IV+
Re-186	ENDF/B-VI	ENDF/B-IV+

A comparison should be made between ENDF/B-VI and JENDL-3 for the S evaluations before the final decision is taken.