

## STATUS OF THE JEFF PROJECT - 2009

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### Introduction

The JEFF project involves evaluation efforts that cover the main nuclear data needs in the fields of fission and fusion applications in Europe. The overall structure of the project is depicted in fig. 1. Development of the JEFF libraries is not directly financed, and is based on the voluntary participation of European institutes and scientists. Staff at the NEA Data Bank ensure the maintenance of the JEFF library, and two JEFF meetings per year bring together experts in different areas such as data evaluations, experimental studies, reaction modelling, verification and compilation of the data, file processing and benchmarking.

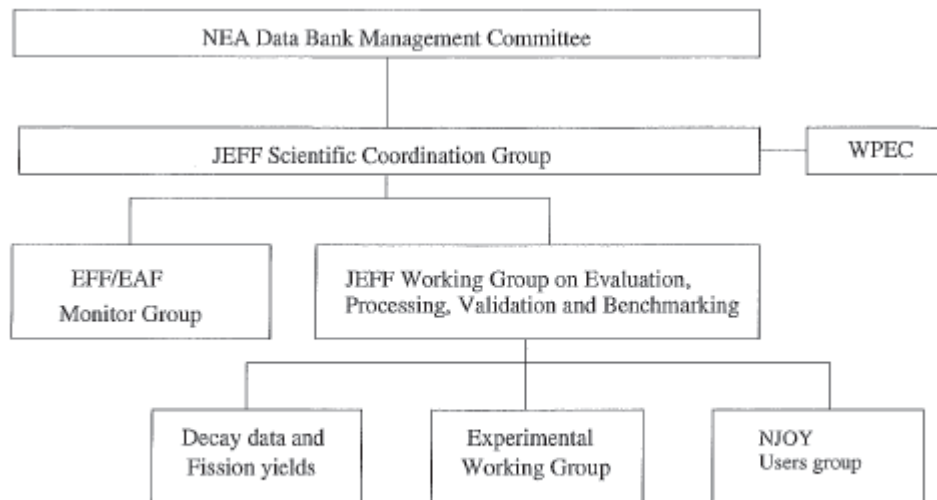


Fig. 1. Organisation of the JEFF project.

### Status of JEFF-3.1 and the JEFF-3.1.1 release

The latest official version of the JEFF-3.1 library was released in May 2005, and consists of the following sub-libraries:

- neutron general purpose library: 381 isotopes or elements,
- neutron activation library: 12617 neutron-induced reactions on 774 target nuclei, which is based on the European Activation File EAF-2003,
- thermal scattering law library: 9 materials,
- decay data library: 3852 isotopes
- spontaneous and neutron fission yield data library: 19 isotopes,
- proton special purpose library: 26 isotopes.

### **JEFF-3.1.1 RELEASE AND VALIDATION**

JEFF-3.1 has been in use since May 2005. Various problems, ranging from small to significant, have been reported since its release. Details can be found at [www.nea.fr/html/dbdata/jeff3feedback/feedback-31.html](http://www.nea.fr/html/dbdata/jeff3feedback/feedback-31.html). Among the more important feedback for the general purpose file is:

- Np-237 underestimation of the thermal capture cross section.
- Change of the upper limit of the unresolved resonance range for Pu-239.
- Need to revise 7 FP's to satisfy integral FP inventory experiments.

It was decided to produce an intermediate release, JEFF-3.1.1 at the beginning of 2009, in which the corrections of the feedback list are implemented. Meanwhile this library has been validated and is in actual use by the French nuclear industry. The results of a large validation program is available in JEFF Report 22 of which we show the forward here:

*This report describes the incremental method used to improve JEFF evaluations since the release of the JEF-2.2 library in 1992. In order to be accepted as a JEFF-3 evaluation, new evaluations must be demonstrated to be more consistent with both differential and targeted integral measurements. The report first describes the validation of the JEF-2 library and the user feedback received by evaluators. The main improvements introduced in the JEFF-3.0 file, and in a second step in JEFF-3.1, are then presented. The report highlights the modifications that would be required for JEFF-3.1 evaluations to fit with integral experiments and to meet LWR target accuracy. The new evaluations (237Np, 239Pu, 160,91,96Zr and seven fission products) introduced in the recommended JEFF-3.1.1 file are also described.*

*The current validation of the JEFF-3.1.1 file is detailed. Fundamental targeted experiments, LWR mock-up experiments, PWR and BWR chemical assays and SNF reactivity worth measurements are analysed using both TRIPOLI4 and APOLLO2.8 reference calculations.*

*This report demonstrates that JEFF-3.1.1 is probably the best international library currently available. It is more accurate than ENDFB/VII for fuel inventory, MOX reactivity and plutonium ageing, and reactivity coefficients such as temperature coefficient and stainless steel reflectors. Moreover, JEFF-3.1.1 evaluations benefit from the feedback of validation studies for fast breeder reactors, the fuel cycle, criticality safety and burn-up credit.*

*JEFF-3.1.1 is used worldwide for PWR and BWR calculations, particularly in the new ARCADIA package of Areva-NP. It is also used in ERANOS2 for Generation IV designs.*

### **JEFF-3.2 DEVELOPMENT PLAN**

The next step is to develop and issue an updated and extended version of the JEFF-3 library called JEFF-3.2 along with the corresponding documentation. The expected release for JEFF-3.2 is the end of 2010.

The delivered JEFF-3.2 library will be composed of:

- A General-purpose file based on the JEFF-3.1.1 library plus modifications and extensions.
- Decay Data and Fission Yields libraries based on the JEFF-3.1.1 libraries plus modifications and extensions.
- An Activation Data library.
- A Proton, Deuteron and Photonuclear Data library.

## I. JEFF-3.2 General Purpose library

The final release of the previous mandate has been renamed JEFF-3.1.1. This library includes the necessary changes needed for JEFF-3.1 to turn it into a well-performing validated library for nuclear industry. The next major release will thus be JEFF-3.2.

### 1) Corrections to JEFF-3.1 deficiencies

A list of errors or inconsistencies in the JEFF-3.1 library is compiled by the secretariat from the users feedback (see <http://www.nea.fr/html/dbdata/jeff3feedback/feedback-31.html>). This list of feedback is reviewed at regular JEFF meetings and possible solutions are discussed and approved. The corrected files will be adopted in the JEFF-3.2 library.

### 2) New neutron evaluations

New, updated and extended evaluations produced in Europe during the current mandate period of the Project will be considered for inclusion in the JEFF-3.2 library. In addition, the best possible evaluations from other data libraries will be adopted. The following provisional list was compiled from several sources. In this list, the energy range of most measurements is limited to 20 MeV. However, many evaluated data files extend up to 200 MeV.

Nuclide	Revised reactions	Energy range	Milestone	Contributor
Ne isotopes	All	up to 200 MeV	2009	NRG
Na-23	All	Up to 200 MeV	2010	NRG-CEA
Cr isotopes	All	up to 150 MeV	2010	EFF project
Mn-55	All	up to 150 MeV	2010	EFF project
Tm-169	All	up to 200 MeV	2009	NRG
Yb isotopes	All	up to 200 MeV	2009	NRG
Hf isotopes	All	up to 20 MeV	2010	Birm./Serco/Geel/CEA
Ta-181	All	up to 150 MeV	2009	EFF project
W isotopes	All	up to 150 MeV	2009	EFF project
Os isotopes	All	up to 200 MeV	2009	NRG
Pt isotopes	All	up to 200 MeV	2009	NRG
Tl isotopes	All	up to 200 MeV	2009	NRG
Pb isotopes	All	up to 200MeV	2009	NUDATRA
Bi-209	All	up to 200MeV	2009	NUDATRA
Th-232	All	up to 150MeV	2009	IAEA
Pa-233	All	up to 150 MeV	2009	IAEA
U-235-239	All	up to 20 MeV	2010	CEA
Np-237	RRR+URR	up to 20 MeV	2009	CEA
Pu-238-240	All	up to 20 MeV	2010	CEA
Am-241	All	up to 20MeV	2009	Nudatra, CEA

In addition, the evaluations of important fission products will be revisited. The EFF data evaluations will include all data types required for fusion neutronics calculations and related uncertainty assessments (e. g. energy-angle distributions of secondary particles and recoil nuclei, gamma production data, co-variances). Extension to energies above 20 MeV is required to provide the data for neutronics calculations of the IFMIF neutron source. According to the requests of the European Fusion Programme, the extension and update of other EFF data evaluations may be considered during the JEFF mandate period.

### 3) Covariance data

The JEFF-3.1 library still contains too little information about nuclear data uncertainties and their correlation. The project will aim at producing covariance data for important nuclides such as U-235, U-238, Pu-239, all Hf isotopes, H-1, Li-6,7, and O-16. Results from various WPEC subgroups on resonance covariances, nuclear models covariances and processing issues will be of help to this.

### 4) Gamma production data

Gamma production data are important for various applications including gamma heating and radiation shielding. The development and validation of the JEFF-3.2 library should address the most important nuclides such as fuel nuclides (U-235, U-238, Pu-239). In addition gamma production data for fission products will be addressed to enable a more precise prediction of energy deposit in control rods and moderators.

### 5) Benchmarking studies

A continuous effort will provide the experimental validation of the JEFF-3.2 general purpose library. As a result, recommendations will be made in order to improve the prediction capabilities of the file. For JEFF-3.1 a co-operative effort was undertaken to solve the origin of the low prediction of LWR lattices reactivity. For JEFF-3.2 there will be extra emphasis on fast systems, which characterise several GEN-IV and transmutation designs.

## II. JEFF-3.2 Decay Data and Fission Yield libraries

The development of the decay data and fission yield libraries will be carried out in the following directions:

- Correction of inconsistencies revealed during the checking procedure
- Extension of the library to include spectral data for important nuclides
- Validation of the library for decay heat calculations and fission product inventories.
- Address the issue of adding covariance information to the data.

## III. JEFF-3.2 Activation Data library

The latest release of the European Activation Library (EAF) will be adopted as JEFF-3.2/A file. EAF-2009 (in the ENDF-6 format) is expected to be released during the year 2010. The library will cover the energy range up to 60 MeV, and so will be applicable to calculations of the IFMIF neutron source. Validation of the EAF library based on a wide range of experimental results is directly applicable to the JEFF-3.2/A file.

## IV. Other

### 1) Photonuclear data

New photonuclear data are currently being developed in Europe. The aim is to produce a photonuclear sublibrary of JEFF.

### 2) Proton data

Both a complete proton transport and activation library will be produced. This library will largely be based on the TENDL-2009 library. The choice for TENDL-2009 (or TENDL-2010 etc.) can be overruled by individual evaluations.

### *3) Deuteron data*

Both a complete deuteron transport and activation library will be produced. This library will largely be based on the TENDL-2009 library. The choice for TENDL-2009 (or TENDL-2010 etc.) can be overruled by individual evaluations.

More specific deuteron transport libraries will be created for (at least)  $d + \text{Li-6,7}$ .