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EFF PROGRAMME 1995

Neutronic Data improvement for breeding blankets

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1. Introduction

The DEMO Neutronics Working Group has written a note on the necessity of Neutronics data improvement [1], stressing the needs for improved data and uncertainty assessment for breeding blankets. The European efforts on nuclear data, also known as NDB1 or EFF projects [2], were during the last three years directed to shielding blankets, rather than breeding blankets. In the early years of the EFF project there was more emphasis on breeding blankets and from this period there is still quite some experience in various European laboratories on nuclear data evaluation of neutron multipliers and tritium breeder materials. In the last years the main empasis was on structural materials [3].

The EFF-project is now re-directed to breeding blanket nuclear data needs and that previous contractors of NDB1 perform a cooperative effort to meet the need of the Neutronics Working Group of the Blanket Co-ordination Group.

2. Integral EFF programme 1995

Translated in terms of needs the folllowing points should be considered by the EFF evaluators:

2.1. Sensitivity and uncertainty analysis

It is important to perform a sensitivity analysis on the tritium breeding ratio using EFF-1 and -2 (and perhaps FENDL-1) in order to identify the most critical needs and energy ranges. This is also useful to identify the need for covariance data. A similar exercise is in place for the heat-deposition density. To this end simple computational benchmarks will be defined. It is noted, that some tools needed for such calculations were already developed in the framework of the NDB1 project. Further work on this item is necassary, in particular to update the covariance working file and the connection with the SUSD sensitivity and uncertainty code.

A preliminary uncertainty analysis on the t-breeding ratio (and the heat deposition) can be made only with EFF-1, since uncertainty information for key-elements like Li and Be is lacking in EFF-2 and other recent evaluations. Still this could be a useful exercise and the same computational benchmarks could be used. Such benchmark could give a better understanding of the importance of covariance analysis for the breeding ratio. If tools are available in time these calculations should be performed in 1995, otherwise in 1996.

2.2. Evaluation work and improvements of EFF

2.2.1. Structural materials

Here EFF-2 is a very good starting point and by the end of 1994 we expect a further update of Fe-56 (EFF-3) ready with much better quality (fluctuations in unresolved range, particle, gamma and recoil distributions in file 6, realistic covariance data). Similar work could be done for Ni and Cr isotopes, but in view of the low priority for shielding blanket calculations it is recommended to to concentrate in 1995 only on Cr (although work on Ni could be done with little more effort). For Cr also the resolved range should be updated (suggest joint action of Vienna, Bologna, Petten, Geel). From the minor structural materials there are recent EFF-2 updates for Mo-isotopes and Si, whereas V has recenly been updated in the frame of EFF-3 for 1994. Updates of Mn, Nb may have to wait.

2.2.2. Neutron multipliers (top priority)

Elemental Pb in EFF-2 has been improved recently and competes with the ENDF/B-VI-=FENDL-1 isotopic evaluations. Still it is recommended to continue with FENDL-1 for the reason that these are isotopic evaluations with uncertainty estimates and full file 6 data. Work is required in the resolved resonance range, which could be imported from EFF-2 and a comparison of lumped isotopic evaluations with experimental data is needed. This work may have to wait until 1996.

For Be there are several problems in all recent evaluations , as has been outlined e.g. by U. Fischer. There are no covariance data available. A revision of Be (EFF-2) is most urgent. It should be done by re-distribution of the various components of (n,2n) and possibly by some adjustment of the angular distribution in the cm-system as well. The best procedure would in my opinion be to fit the various distributions (assuming the angular and energy distribution is correct) to experimental differential data by means of the GLUCS code used in Vienna. This gives uncertainties and covariance data as a by-product. It requires additional information from Birmingham University, since these components are not stored on file at Petten (like for Li). It is recommended to adjust the components of (n,2n) to experimental data and thereby add uncertainty data to these components (Birmingham, Vienna, Petten). There could also be a need to add distributions of other particles and recoils. There are covariance data given in EFF-1, which could be used for provisional calculations. Covariance data from the above-mentioned adjustment procedure should be stored in file 33. Some modifications in uncertainty processing codes should be made to process these data. There is a need to check gas production cross sections for Be.

2.2.3. Components of breeder materials

The main problem in Li is that uncertainties are not given in recent evaluations. They are however available for EFF-2 for the data in file 3 (not given on the present data file !). There are also uncertainty data given in EFF-1. The advantage of Li in EFF-2 is that cross sections for different components of the t-production cross section are available (not on the present data file), which makes it possible to adjust the data with the GLUCS code even without assistance from Birmingham. For adding charged-particle and recoil distributions a contribution from Birmingham could be required. The recommendation is to adjust the components of the t-production cross section of Li-6 and thereby add uncertainty data to the components (Vienna, Petten). The uncertainty data of the components could be stored in file 33 and provisions are needed to process these data. For Li-7 there are no large data needs, also

because of the use of enriched Li-6.

For Al and Si work is in progress at ENEA-Bologna to provide these cross sections with recoils for all reactions (already done for binary reactions). I see minor additional work to improve photon spectra by adding discrete gamma-lines for inelastic scattering, by the Bologna group (work to be done in 1996?).

For Zr isotopes the starting point could be the BROND evaluations, but file 6 has to be added with distributions for all outgoing particles, photons, recoils. This could be done either at Bologna or Petten. A similar activity should be done for Ti-isotopes (1996 ?).

For O improvements may be necessary for the (n,α) cross section and perhaps on double differential cross sections (file 6). This work should be postponed to 1996.

For all materials, but in particular for the light materials it is important to check the gas-production cross sections, e.g. by intercomparing with those derived from the European Activation File.

2.2.4. Coolant materials

Except for the remarks made above on oxygen there are no evident needs for improvements.

2.3. Production of derived data files

The new or modified materials of EFF-3 should be processed to get derived data files for multigroup transport calculations, Monte Carlo calculations, uncertainty calculations and response function evaluation (dpa, kerma, gas production). This work should be routine, if the data improvements are made according to state-of-the-art methods. Verification of the data files could be time-consuming. Traditionally this work has been made at ENEA-Bologna/Frascati.

However, some new features in Li and Be may require special attention. In particular it is required to update the processing routes for sensitivity and uncertainty calculations for the covariance information of double differential cross sections of Li and Be. Here a simple method is proposed by ECN-Petten, rather than entering large new developments. It could be necessary to evaluate the contribution of nuclear data uncertainties to "direct" kerma as well.

2.4. Benchmarking

The new data should be benchmarked using experimental data on the tritium breeding ratio. Various European laboratories are equipped for such calculations.

3. Individual contributions (PROPOSAL)

This section contains a revised proposal for 1995, taking into account necessary reductions.

EFF-BB1: Project coordination , file management, etc.
(ECN-Petten)

1. Coordination overall project and file management	0.3 pmy
	0.3

EFF-BB2: Evaluation activities and processing
(ENEA-Bologna and Frascati)

1. Evaluation activities Cr, Zr,... (Bol.)	0.8 pmy
2. Multigroup data processing (Bol.)	0.1
3. MCNP processing (Frasc.)	0.1
	1.1

EFF-BB3: Evaluation low-E structural materials, benchmarking
(KfK-Karlsruhe)

1 Update low-E data (structural materials)	0.4 pmy
2 Benchmark activities (Be,Li,Pb,Al,Si)	0.3
	0.7

EFF-BB4: Computational tools for sensitivity and uncertainty evaluation
(CEA-Saclay)

1. Update cov. file,	
2. Update sensitivity code,	
3. 3D sensitivity analysis (Saclay)	0.5 pmy

EFF-BB5: Evaluation Be, Li, Cr
(IRK-Vienna)

1. Adjustment of Be model calcs. to exp. data incl. covariances	0.6 pmy
2. Adding covariances Li-7	0.1
3. Improved Cr data with covariances	0.1
	0.8

Total manpower **3.4 pmy**

4. References

[1] DEMO Neutronics Group (L. Giancarli, U. Fischer and L. Petrizzi), EU test Blanket Development Programme- Neutronic Data Improvement in 1995, July 20

[2] H. Gruppelaar and J. Kopecky, Status report EFF/EAF projects May 1994 - European Fusion and Activation File Projects, ECN-RX--94-036, presented at Int. Conf. on Nuclear Data for Science and Technology, Gatlinburg, Tennessee, USA, May 1994

[3] J. Kopecky, H. Gruppelaar, A. Hogenbirk, H.A.J. van der Kamp and D. Nierop, European Fusion File EFF-2.4 - Final report on basic data file-, ECN-C--94-016, July 1994