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INDC **INTERNATIONAL NUCLEAR DATA COMMITTEE**

PLANNING FOR THE REAL-84 PROJECT ON ADJUSTMENT PROCEDURES

Report of an IAEA Consultants' Meeting held
in Hamburg, Fed. Rep. of Germany, 26 September 1984

Compiled by V. Piksaikin and W.L. Zijp

July 1985

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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1. Introduction

As a continuation of the IAEA Consultants' Meeting on the REAL-80 exercise, held 13-15 June 1983 in Vienna [1], a second Consultants' Meeting with extended participation was organized also by IAEA in Geesthacht, parallelly with the 5th ASTM-EURATOM Symposium on Reactor Dosimetry. The participants had an overview on the tasks formulated in the proceedings of the previous consultation, the progress in the preparatory work and arrived at a more detailed planning for continuation of this project, called REAL-84.

2. Aim of the REAL-84 project

The participants of the meeting agreed that the aim of the REAL-84 project should be - as reported in the related symposium paper [2] - improving the assessment of accuracies in radiation damage predictions by using good quality input data and proper calculation methods. Special emphasis to the input spectrum and cross-section covariance information should be given. More information on the subject can be found in Ref. [1] and [2]. Participation of all laboratories should be encouraged which are able to determine the uncertainty values in damage parameters derived from the adjusted neutron spectra with the application of all available input information.

3. Review of data requirements

The input data set for the exercise should contain the following information:

- group cross-sections with their covariances from IRDF or ENDF/B-V;
- realistic input spectra with their covariances;
- measured reaction rates with proper covariance matrices (if the correlations between the different reaction rates are not known, zero values have to be used).

Recommendations on removing some characteristic reaction rates for checking the results of the adjustments were made. The dpa and the gas production cross-sections should be available for the steel compositions considered. These data should be derived from the ENDF/B-V library or from the ASTM recommentation.

The following neutron spectra - for which all the input information is available - were decided to be included in the exercise:

ANO-I,

ORR-PSF-1/n T,

and RTNS-II or Be(d,n) spectrum depending on the availability of the input information.

The input data set is composed from the best data available, which does not mean that consistency is guaranteed.

4. Recommendations and actions

The following procedures were recommended concerning the REAL-84 exercise.

a. Participants should be limited to those using adjustment codes which explicitly consider covariance data.

b. All test spectra should contain evaluated covariance data.

c. In cases where data are inconsistent or missing entirely, participants should be told only that the data are not available. For example, that no correlations are known for this case (activities, cross-sections, etc.).

d. ENDF/B-V dosimetry cross-sections should be used in the exercise.

e. Spectra to be used for the exercise should include:
   1. the ANO-I surveilliance spectra;
   2. PCA/PSF benchmark spectra; and either
   3. an RTNS-II 14 MeV fusion simulation spectrum or a Be(d,n) (16 MeV) accelerator spectrum.

f. Participants will be expected to calculate dpa and He production for each spectrum for Fe, steel (ASTM), and possible sapphire.
   One or two activation reaction rates will also be calculated for the adjusted spectrum.

It is recommended that IAEA take the following actions concerning the REAL-84 exercise.

1. A standard procedure should be established to process cross-section covariance data files. Due to the wide variation in energy group structures currently in use, a computer code for processing the ENDF covariance file should be distributed along with the file itself. Participants would then be able to choose their own energy group structure without the need to collapse or expand a previously processed group file.
2. The IRDF data file should be made consistent with ENDF formats and group structures, especially regarding covariance data.
3. Computer codes for changing group structures of processed cross-section files should be made available to participants upon request.

5. Time schedule

The time schedule proposed in [2] will be used.

6. Organization

The REAL-84 project will be organized and co-ordinated by the IAEA-NDS The BME and ECN volunteer to assist in the preparation of the input data and in the evaluation of the participants contributions.

7. A Summary of the results of the IAEA Consultants' Meeting on the REAL-84 project was given by Dr. W.L. Zijp and discussed during the 5th ASTM EURATOM Symposium on Reactor Dosimetry (see Appendix 2). In highlights of the Symposium there was pointed out that the REAL-84 project is of great importance for improving the ability to assess the accuracy in radiation damage predictions.

8. References

[1] D.E. Cullen (Editor): "Proceedings of the IAEA Consultants' Meeting on the assessment of the results of the REAL-80 project on cross-section unfolding codes and planning for continuation of this project", Vienna, 13-15 June 1983.

[2] W.L. Zijp, E.M. Zsolnay, E.J. Szondi, H.J. Nolthenius, D.E. Cullen: "Plans for a REAL-84 exercise", To be published in the proceedings of the 5th ASTM-EURATOM Symposium on Reactor Dosimetry, Geesthacht, F.R. Germany, September 24-28, 1984.

List of Participants

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Summary for Proceedings of Geesthacht Symposium

1.Report on the IAEA Consultants meeting on the REAL-84 exercise.

An IAEA Consultants meeting was held on 26 September 1984 on the REAL-84 exercise. The meeting was attended by 11 invited experts. Here a short summary is given of the main results of the discussions.

The REAL-84 exercise should improve the assessment of accuracies in radiation damage predictions, and thereby promote the use of specialized adjustment procedures. It was realized that there are no problems with the adjustment codes themselves, but that there are problems with the input data needed for the adjustment. The exercise will underline the need for new or better data, since input data sets may show incomplete data, missing data and maybe inconsistent data.

The participation should be open for all laboratories which use adjustment codes which are able to take into account covariance data.

The participants should critically review the input data, perform spectrum adjustments, calculate some spectrum characteristics and calculate some integral damage parameters.

Thus the participants will be expected to calculate displacements per atom and helium production for each spectrum for iron, for steel and possibly for sapphire. One or two activation rates have also to be calculated for the adjusted spectra.

Spectra to be used for the exercise should include

a. the ANO-1 surveillance spectrum,
b. the PCA/PSF benchmark spectrum and
c. either the RTNS-II, 14 MeV fusion simulation spectrum, or a Be (d,n) 16 MeV accelerator spectrum.

All test spectra should contain evaluated covariance data.

It is recommended that the IAEA take the following actions concerning the REAL-84 exercise.

1. A standard procedure should be established to process cross section covariance data files.
   Due to the wide variation in energy group structures currently in use, a computer code for processing the ENDF covariance file should be distributed along with the data file itself. Participants could then be able to choose their own group structure without the need to collapse or expand a previously processed group file.
2. The International Reactor Dosimetry File (IRDF) should be made consistent with ENDF formats and group structures, especially regarding covariance data.
3. A computer code for changing group structures of processed cross section files should be made available to participants on request.

W.L. Zijp

2. Report on the Workshop "Adjustment Problems"

The workshop on this topic was at the same time a meeting of the ASTM E 10.05.01 Task Group for Uncertainty Analysis and Computational Procedures. The workshop started with a summary by W.L. Zijp (ECN) on the IAEA Consultants Meeting on the REAL-84 exercise, held the previous day (see the report above).

F.W. Stallmann (ORNL) underlined that nowadays spectrum adjustment should be performed with the statistical methods based on the least squares principle, which methods imply that variances and covariances must be determined for measured reaction rates, cross sections and calculated group fluences.

This task is far from routine for the fluence and cross section data, particularly with regard to covariances. Many researchers are therefore reluctant to use adjustment methods, or try to make improper simplifications. He invited the audience to discuss these difficulties in order to initiate the establishment of guides and standardized procedures to provide the necessary help for the application of these adjustment procedures.

As first step towards this goal he proposed the following actions:

1. The simplification of the variance-covariance information for neutron metrology cross sections. The current ENDF/B-V and the special dosimetry file use 4 different formats for this information and require complicated processing codes to convert to a given energy group structure.
   Proposed is a generation of a simple variance-covariance matrix in some agreed upon group structure, consistent but much coarser than the 620 group structure of the present dosimetry cross section file.
2. Establishment of guidelines for the determination of calculated fluence variances and covariances. Such guidelines may be facilitated and promoted by the work of R.E. Maerker (ORNL) on the calculation of fluence covariance matrices.

After these statements Mr. Stallmann discussed the basic relation between any physical quantity x,(which is a function of fluence, cross sections and reaction rates) and the residuals; he showed futhermore the relation between the covariance of this quantity x and the covariances between residuals and the covariances between x and these residuals. Each activation detector reaction has a typical cross section variance which is not so sensitive to the spectrum shape. The covariance matrix of the residuals shows high correlations and is not sensitive to slight changes in the neutron spectrum. Therefore simplification and standardization of the determination of covariances appears feasible. There is a challenge to provide some recommendation. The ASTM should establish guidelines for transport calculations which can also derive covariances for spectra.

Mr. R.E. Maerker (ORNL) presented some details of his work for the calculation of typical fluence and covariances for 3 locations (reactor cavity location, T/4 location, surveillance location) in the ANO-1 reactor. He discussed sources of fluence rate uncertainties, considered in the calculation of the covariances for each of the three locations.

Mr. K. Weise (PTB) drew the attention to a draft German standard (DIN 1319, Part 4) on the treatment of uncertainties (inclusive covariances) in the evaluation of measurements. He distributed an English translation, from which it became clear that this document is very helpful with respect to the terminology and procedures.

Mr. C.M. Eisenhauer (NBS) discussed uncertainties in the spectrum averaged cross section values of uranium and plutonium in the californium and ISNF benchmark fields.
Also some other topics were discussed: the physics information content of the covariances of the parameters in the Watt and the Maxwellian representation of the standard fusion neutron spectra, and the merit of covariances of a standard spectrum in its normalized form.
At the end of the workshop the audience was invited to assist where possible in establishing written recommended procedures via ASTM and/or other channels.

F.W. Stallmann
W.L. Zijp