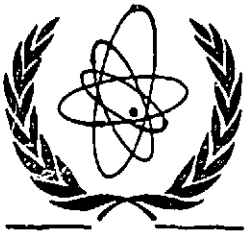


International Atomic Energy Agency

INDC(NDS)-328
Distr.: L
December 1994

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

Development of an International Nuclear Decay Data and Cross-Section Database

Summary report of an IAEA Specialists Meeting

Vienna, 24-28 October 1994

H.D. Lemmel (ed.)

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

Printed by the IAEA in Austria
November 1995

INDC(NDS)-328
Distr.: L
December 1994

Development of an International Nuclear Decay Data and Cross-Section Database

Summary report of an IAEA Specialists Meeting

Vienna, 24-28 October 1994

H.D. Lemmel (ed.)

Abstract: An IAEA Specialists' Meeting proposes procedures describing how an internationally accepted database of high-priority nuclear decay data and thermal neutron cross-sections can be developed through a network of experts coordinated by the IAEA Nuclear Data Section.

Contents

Introduction

The IAEA Specialists Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database took place at the Vienna International Center, 24-28 October 1994.

It was opened by C.L. Dunford, Head of the IAEA Nuclear Data Section. A.L. Nichols, UK, acted as Chairman. Two Subgroups were formed: the Decay Data Subgroup was chaired by R.G. Helmer, USA, with T.D. MacMahon, UK, as Secretary; the Subgroup on the Cross-Section Database was chaired by H. Condé, Sweden, with H.D. Lemmel as Secretary, who also acted as Scientific Secretary of the Specialists Meeting.

The meeting, which was attended by 29 nuclear data experts, issued recommendations on procedures for creating an internationally-accepted database of high-priority nuclear decay data and thermal neutron cross-sections.

The conclusions and recommendations are given in the present report. The papers presented at the Meeting are contained in report INDC(NDS)-329.

Note: Due to budget reductions the professional staff of the IAEA Nuclear Data Section was reduced by two in Dec. 1994/May 1995. Consequently, the actions resulting from this meeting, could not yet be implemented.

IAEA Specialists' Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database

Opening statement

C.L. Dunford

Dear Colleagues,

You have accepted the Agency's invitation to participate in this Specialists Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database. We are pleased to see that the announcement of this meeting found such a wide positive response. During the forthcoming week you will have the task to formulate the terms of reference of international cooperation to create and maintain a new internationally agreed standard reference nuclear database.

The nuclear data programme of the IAEA is now 30 years old. In the beginning, certain nuclear cross-section data were classified information, and it took several years until free exchange of nuclear data could be agreed and organized.

The next step was the creation of international data file formats so that nuclear data compiled in one country could easily be exchanged to other countries, through the network of nuclear data centers.

Information exchange is among the primary tasks in the Statute of the IAEA.

Another essential element in the Agency's nuclear data programme is the provision of standard reference nuclear data files so that nuclear measurements in different countries are standardized. To this goal several databases have been created earlier, specifically

- the INDC/NEANDC Nuclear Standards File for Nuclear Measurements;
- the Transactinide Nuclear Data File;
- the International Reactor Dosimetry File, IRDF;
- the X- and Gamma-ray Standards for Detector Calibration;

and a few more.

These files have been established in different forms of international cooperation, partly as Coordinated Research Projects, and partly in a less formal way of voluntary cooperation.

We hope that the outcome of your meeting will be a new fruitful cooperation to create and maintain a new international nuclear database to be used in a wide range of nuclear applications.

IAEA Specialists' Meeting on the
Development of an International Nuclear Decay Data
and Cross-Section Database
24-28 October 1994

Objectives of the meeting

H.D. Lemmel

The history of this meeting goes back to the Juelich Nuclear Data Conference in 1991, when Professor Selinov made the proposal to publish an international wall-chart of nuclides. The idea then developed further, and I am not sure whether the expected outcome of this meeting is still the same as the original idea of Professor Selinov.

We do not want to print an international wall-chart of nuclides. Others know it much better how to produce a wall-chart which is informative and decorative at the same time. We also do not intend to develop a "PC wall-chart". There are a few that have been developed recently. May be, the one or other will be demonstrated at this meeting. Our concern is the database that these paper charts or PC charts should contain. Our goal is the development of an international database which will be available to wall-chart producers and all others who need the data.

The International Nuclear Data Committee met in March 1993 to review the programme of the Nuclear Data Section. The INDC assigned the plans for this meeting a high priority. Subsequently, this meeting was also supported by the network of Nuclear Structure and Decay Data Evaluators at its meeting in Berkeley in May 1994.

We are glad that this Specialists Meeting could be organized although it had not been foreseen in the Agency's programme. The meeting had been announced originally as a Consultants Meeting to create an international database for the chart of nuclides. It found soon a strong interest so that we had to upgrade the meeting to a Specialists Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database.

Despite of the changed title we continue to define the data scope of the meeting to cover primarily those nuclear data which were usually included in a wall-chart of nuclides. However, since we have now electronic media we are not fixed to the square centimeter of space which is the space limit for each nuclide on a wall chart. We can include a bit more, and the meeting will have to decide what data types should be included.

There exist half a dozen of nuclear wall charts. The best known are those by KAPL, from Karlsruhe, from JAERI, and most recently the one from Strasbourg, plus Russian and Chinese ones. There exist also handbooks, primarily from Berkeley and Brookhaven, and the databases in ENSDF and ENDF format with many derived products. There are also recommended values by the ICRM and different national standards institutions.

Why do we need an additional project?

Our problem is that, despite of the overall limited manpower, there are too many independent parallel activities. These we want to coordinate. It is disturbing that the different databases do not show the same numbers and uncertainties, even when they are based on the same set of experimental data.

If the IAEA Nuclear Data Center is asked for the thermal cross-section of a given nuclide, we can only quote the values from ENDF/B-6, JENDL-3, JEF-2, BROND-2 and CENDL-2, but we cannot give an internationally recommended value. We also note a default of the ENDF format that such important parameters as the thermal cross-section and the resonance integral, both with their uncertainties, cannot conveniently be stored and retrieved. If at all, one finds them in the free text only.

With nuclear decay data we have the advantage that ENSDF is recognized as an international database. Its strength is the evaluation of nuclear level schemes. The evaluation of half-lives of ground-states and isomers in ENSDF, however, has not found the same international recognition as the level schemes. There are some good half-life evaluations that cannot be found in ENSDF, for various reasons. The ENSDF network has recognized the need for additional work on half-life data, and we will hear of this later in this meeting. Although many published half-life tables are now based on ENSDF, some of the wall-chart activities and other nuclear data activities continue to have their own databases for nuclear half-lives.

A difficulty with ENSDF lies in the slow update rhythms. When a new half-life evaluation has appeared, this should show up in an international database without delay. In ENSDF, so far, it could be entered only when the relevant mass chain was updated, and that could mean a delay of several years.

All existing activities have their merits, and we wish to encourage all of them to continue. We wish to support and coordinate these activities by the development of an international agreed database. We call for your cooperation.

The task is big. It will certainly not be possible to have this database complete from the beginning. We will have to start with a subset of the more important nuclides. In agreement with the mandate of the IAEA we shall have to give priority to those data types and nuclides that are important for practical applications. We should gradually expand them to a more complete data scope, as manpower permits.

We wish to obtain international recognition for this database. This will be possible only under three conditions:

1. We must have "terms of reference", i.e. good agreed procedures for updating and maintaining the database.

2. The database must have a high quality standard. Every value and its uncertainty must be well documented. A reference on the evaluation must be given. If the evaluation is not published elsewhere, we offer our INDC report series for this purpose.

3. We must have a well-defined distribution list for the database addressing national standards institutions; editors of handbooks, wall charts and PC databases; the data centers who maintain ENDF formatted data libraries, ENSDF, etc; and international institutions such as ICRM, IUPAC, and others. At the same time, such institutions must be invited to provide input according to our "terms of reference".

It will be the task of the subgroups to consider these items.

We have several members of the INDC present at this meeting. I have the feeling that the cooperation that we are going to start, should be somehow under the auspices of the INDC, specifically of the INDC Standards Subcommittee. Consequently, I feel that our cooperation should report to the INDC, so that progress and any problem that may arise would be discussed at the biennial INDC meetings. The next will be in spring 1995.

At its last meeting the INDC had considered that our meeting may issue recommendations about Coordinated Research Projects (CRP's) to be organized by the IAEA. This would involve research contracts (with financial support), research agreements (without financial support) and research coordination meetings. Such CRP's require several years of preparatory time, and they would require a strong justification in view of practical applications. An example was our CRP on the measurement and evaluation of x-ray and gamma-ray standards for detector calibration. A CRP would certainly not be the appropriate umbrella for our cooperation for the proposed international database. We have to organize this cooperation in an informal manner, in a similar way as our data center networks are functioning. But if a suitable topic for a CRP is encountered, corresponding suggestions would be welcome. They would have to be submitted to the INDC for review.

We planned to have two subcommittees during this meeting,

- a subcommittee on decay data,
- and a subcommittee on cross-section data.

Originally, we were thinking of a third subgroup on evaluation procedures. However, it appears that the evaluation problems are a bit different for decay data and for cross-section data, so that the topic of evaluation procedures will have to be addressed by both of the subgroups. Both subcommittees should consider

- "terms of reference" for procedures to update and maintain the database;
- rules for data evaluation and assessment of uncertainties;
- any data sets that could be adopted as a starter for the international database;
- the workplan of potential contributers; consideration who else should be invited to contribute;
- a distribution list for the first version of the database.

There is a separate paper with a draft of the tasks of the subgroups. This is submitted to the meeting for consideration.

The first sessions of this meeting shall be devoted to listen to the views of the participants. We should then set up the subgroups and define their tasks.

IAEA Specialists Meeting on the Development of an International Nuclear Decay Data and Neutron Cross-Section Database

Conclusions

1. Introduction

The aim of the Specialists Meeting was to provide a forum in which to discuss and recommend methods to achieve the formation of an internationally-accepted database of high priority decay data and thermal cross-sections. Experts in data evaluation and in the preparation of databases attended the 5-day meeting; notable exceptions were China, Japan and Germany from whom written statements of support were received. There were 29 participants from 9 countries and 2 international organizations.

Two Working Groups were formed to discuss and provide recommendations on

(a) Decay data,
(b) Thermal neutron cross-sections and resonance-integrals.

It should be noted that the creation of a comprehensive and carefully evaluated database to an agreed international standard is not achievable on a realistic timescale due to limited resources. Therefore, it was decided to establish a database to be described as a subset (in terms of the extent of the data included and the number of radionuclides evaluated in depth). The proposed database will start from small sets of data that have already received international approval by the International Nuclear Data Committee (INDC) or have been generated by IAEA sponsored Coordinated Research Programmes (CRP). Additional data can then be added to this database as more comprehensive evaluations are made, reviewed and approved.

2. General Recommendations

2.1 The meeting concluded that there was sufficient interest in preparing an internationally-accepted database, and that the IAEA Nuclear Data Section should provide the administrative structure to coordinate and support these efforts. This work of the IAEA-NDS would include the maintenance and distribution of the database.

2.2 The IAEA Nuclear Data Section should produce and disseminate a newsletter of relevant activities within the framework of this international activity.

2.3 Progress in the preparation and development of the internationally-accepted database needs to be reviewed by a Consultants Meeting in 1996, with the expected need for a CRP to undertake measurements and evaluations of the required data in specific areas.

2.4 The IAEA Nuclear Data Section will maintain close contact with the NEA Data Bank to avoid any duplication of effort.

2.5 The goal is that the data from the internationally-accepted database should be included in all other database and publications such as NUDAT, NUBASE, Charts of Nuclides on paper or PC, handbooks, national standards, etc.

3. Working Group Recommendations

3.1 Evaluations to be considered for inclusion in the international database

- must follow the recognized procedures of data evaluation and uncertainty assessment; for further details see the subgroup reports;

- must be adequately documented in publications or submitted for publication in an INDC report.

3.2 A suitable review structure was outlined in the subgroup reports Sections 2.1 and 2.3 (Decay Data) and Sections 4 and 5 (Cross-Section). This review procedure should be followed to achieve the desired international recognition of the database.

3.3 The IAEA Nuclear Data Section is asked to distribute to potential evaluators the evaluation rules as described in the subgroup report on Decay Data (Sections 2.2, 2.6 and 2.7) and Cross-Section (Section 4).

3.4 It is important that the IAEA Nuclear Data Section identifies a comprehensive list of organisations (data centres, organisers of wall charts, national standards laboratories, etc.) that would potentially use such data, and ensure that they are informed of the contents of the internationally-accepted database, and its further development.

Appendix 1

IAEA Specialists' Meeting on the Development of an International Nuclear Decay Data and Neutron Cross-Section Database

Report by the

Decay Data Subgroup

Session I

11:35 - 12:55, Tuesday 25 October

Chairman: Dr. Richard G. Helmer, Idaho Falls, USA
Secretary: Dr. T. Desmond MacMahon, Ascot, UK

1.1. Survey of data evaluation activities of subgroup members:

Helmer, Idaho Falls:	ENSDF mass-chain evaluator, intending to evaluate decay schemes of 200-300 radionuclides for applied spectroscopy.
MacMahon, Ascot:	evaluations of half-lives and gamma ray emission probabilities; measurements of these data; testing of evaluation techniques for descrepant data.
Woods, NPL:	no direct funding for measurements nor evaluations at the present time; do recommend decay data to UK users from the various databases.
Bortels, IRMM:	no evaluations carried out in last 2 years since the retirement of Bambynek; published: ^{192}Ir half-life K-shell fluorescence yields of K, Ca, Cu and $p_\kappa\omega_\kappa$ in the decay of ^{65}Zn.
Molnár, Budapest:	main interest in nuclear structure; developing discrete level scheme library.
Bersillon, Bruyères-le-Châtel:	neutron cross-section evalution; user of decay scheme data.
Audi, CSNSM Orsay:	- atomic mass evaluation AME with Wapstra - NUBASE database with Bersillon, Blachot and Wapstra = critical compilation of ENSDF + AME + updates

Coursol & Bé, LPRI:	- decay scheme evaluations - Table de Radionucléides - Nuclides for nuclear medicine
Antony, Strasbourg:	database for Chart of the Nuclides
De Frenne, Gent:	mass-chain evaluations for ENSDF
Winkler, Vienna:	accurate cross-section measurements, needing evaluated decay scheme data; new interest in nuclides with half-lives > 1 year
Chechev, St. Petersburg:	carrying out evaluations; measurements of Pγ for applied radionuclides; ^{226}Ra, ^{241}Am, ^{244}Cm absolute Px and Pγ to be measured; other activities described in paper presented on Monday.
Golashvili, Moscow:	interested in isotopes from Np upwards and the establishment of an international nuclide chart with the use of recommended and evaluated data.
Vukolov, Moscow:	database for all ground and isomeric states to be published, with Oganessian, Dubna, investigating discrepancies in transactinide data.
Chukreev, Moscow:	ENSDF collaboration; analysis highlighting discrepant data in e.g. ^{239}Pu; reinterpretation of ^{133}Ba decay data.
Schima, NIST:	decay data measurements; needs to produce evaluated data for nuclear medicine: ^{64}Cu, ^{67}Co, ^{68}Ga, ^{68}Ge, ^{117m}Sn, ^{211}At, ^{212}Bi; new revised list of K_α/K_β ratios and ω_k
Browne, LBL:	ENSDF evaluator; Papyrus NSR on CD-ROM; statistical analyses, propagation of uncertainties; Table of Radioactive Isotopes, Gamma-Ray Data on World Wide Web.
Nichols, Harwell:	evaluations of activation products, fission products and heavy element decay data; interested in isotopes for medical applications.

1.2 Suggested scope of data to be included: [see also 2.4]

Parent nucleus:	Z, A atomic mass $t_{1/2}$, J^{π} Q value
Decay properties:	radiation type (β^-, β^+, EC, α, sf) branching ratios transition probabilities and energies
Derived data:	average electron energy per decay average gamma energy per decay
Isomeric states: (≥1 ms)	excitation energies and decay modes
Status comments	

1.3 Possible users of an international database:

geologists	nuclear medicine
radiochemists	environmental studies
research reactors	nuclear fusion
reactor power plants	activation analysts
dosimetry	radioisotope producers
sterilization	radionuclide metrology
education	nuclear physics

1.4 Existing databases:

ENSDF
PTB - $t_{1/2}$, Pγ, Px
IAEA TECDOC-619 - X-ray and Gamma Ray Standards
IAEA Technical Report Series 261 - Transactinium Nuclides
Hans Lemmel list presented on Monday - $t_{1/2}$
JEF 2.2
NUBASE derived from ENSDF + atomic mass evaluation and updated
Table de Radionucléides > 180 nuclides
EME electron emission probabilities
LARA decay data library > 300 nuclides
Antony database
Russia - databases derived from ENSDF
- including handbook on fission product decay data and handbook for industrial users.

NIST fluorescence yield database
LBL Table of Radiaoactive Isotopes
UKPADD
UKHEDD
UKFPDD

1.5 Suggestions for ways of proceeding:

Nichols, Harwell: suggests Audi extracts basic data for all nuclides from ENSDF and adds in results of detailed decay scheme evaluations for a maximum of 400 radionuclides.

MacMahon, Ascot: emphasizes need for reliable quality control and peer review of all new data before entering the database.

1.6 Survey of time participants could devote to developing the database:

Nichols	:	up to 5 hours per week
MacMahon	:	more than 5 mins, not as much as 5 hours per week
Woods	:	none at present
Bortels	:	none at present
Audi	:	can do masses, excitation energies
Bé, Coursol	:	within the LPRI laboratory programme
Antony	:	2 hours/day
De Frenne	:	none
Winkler	:	yes, for long half-life isotopes, within his Institute's Working Programme
Chechev	:	time available
Vukolov	:	yes
Schima	:	1-2 hours/week
Browne	:	co-participation for isotopes on the US evaluation list

Subgroup adjourned at 16:15.

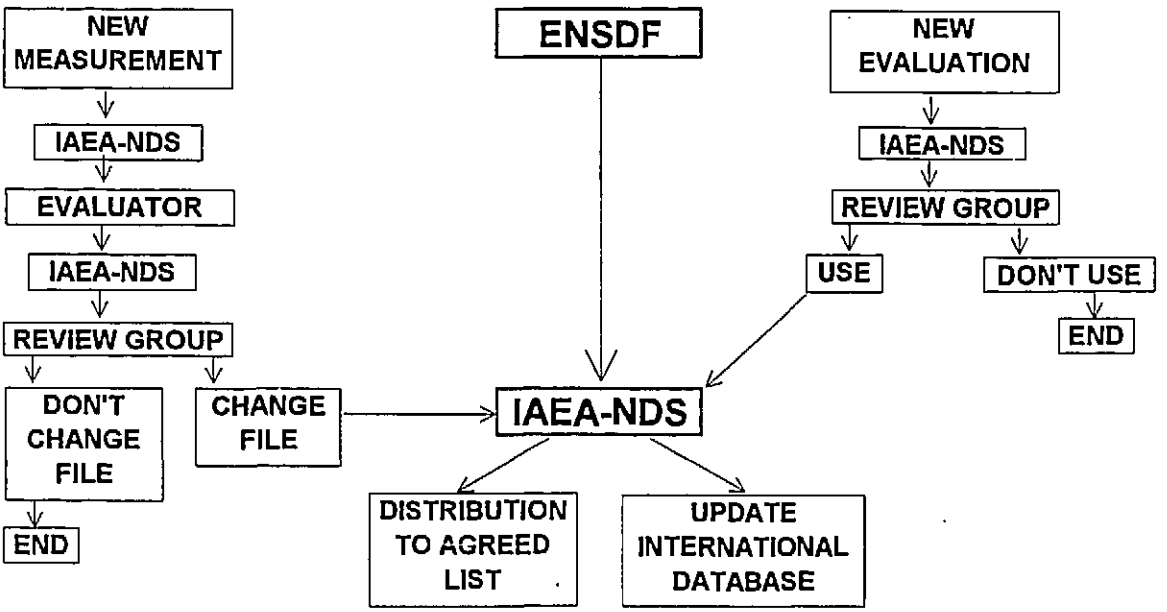
Session II

10:35, Wednesday 26 October

This session discussed the paper 'Outline for a possible cooperation for an international database' which had been presented by H.D. Lemmel at the earlier plenary session.

2.1 Helmer, Idaho Falls, presented a flow chart of a proposed procedure for entering new data into an international database:

Half-lives, Masses, Q-values and Branching Fractions



2.2 ***Evaluation Rules***

The evaluator must:
(i) consider all available experimental values;
(ii) give explicit reasons for omitting any value from final average;
(iii) if the data set is discrepant, compare the result for different analysis methods (see Kafala et al. NIM, A339 (1994) 151-7)
(iv) explain the choice of recommended value.

Woods, NPL, reported to the subgroup the view of M. Woods,. NPL, that data evaluations should continue to be carried out using the method of limitation of relative statistical weight, i.e. the method used by the IAEA CRP on X-ray and gamma ray standards for detector calibration.

2.3 *Membership of the Review Group* (compare Lemmel paper para. 4a)

- the US Nuclear Data Network to nominate a representative (contact: J. Dairiki)
- the coordinator of the Non-Neutron Nuclear Data Working Group of the ICRM to represent the ICRM (A. Nichols)
- F.E. Chukreev, Russia
- Zhou Chunmei, China
- Head of Japanese ENSDF group
- C. van der Leun (as European ENSDF coordinator)
- representative from INDC Standards Subcommittee (H. Condé)
- M.S. Antony, Strasbourg (volunteer)
- M.M. Bé, Saclay (volunteer)
- V.P. Chechev (Russia)
- F. Schima (USA)

2.4 *Revised list of data to be included in the international database*

$T_{1/2}$
mass
decay modes, Q values (cf. Audi, Wapstra tables)
branching fractions
J^{π} for parent g.s. and isomeric states
Spectral information α, no $P_{\alpha i} < 1\%$ of total P_{α}
γ no more than 10 γ-rays
no γ's < 5% relative intensity

Evaluators' discretion to be allowed for numbers of α and γ's
All uncertainties to be quoted, using one standard deviation.

2.5 *Priorities for installing data on the database*

Priority 1: Data in IAEA-TECDOC-619 and in Technical Report Series No. 261 to form the initial database.

Priority 2: Updating the above data

Priority 3: Browne, LBL, to coordinate the formation of a list of approximately 300 radionuclides of interest to applied users, taking account of existing lists such as provided by LPRI, Nichols, Reher IRMM and Russian reference books, Woods, NPL, provided the following list of nuclides of interest to EUROMET:

^{65}Zn, ^{81}Rb, ^{85}Sr, ^{88}Y, ^{73}As, ^{97}Tc, ^{109}Cd, ^{123m}Te, ^{139}Ce, ^{143}Pr, ^{153}Sm, ^{153}Gd, ^{169}Yb, ^{170}Tm, ^{236}Np, ^{241}Pu, ^{155}Eu.

^{226}Ra (+ decay products) was also on the EUROMET list, but was not included as a Priority 3 nuclide.

In the introduction of the international database the reason for its initial low degree of completeness will be explained. For all data not yet included, the users will be referred to ENSDF and its derived products. The NUBASE database will be made available to users through IAEA-NDS.

2.6 Rules for the evaluation of gamma ray emission probabilities

(i) individual Pγ to be evaluated as in section 2.2 above.
(ii) ICC to be evaluated using experimental data where available, otherwise use calculated tables of Rösel (preferred), Hager & Seltzer, or Band for Z≤30.
(iii) carry out a decay scheme balance.
(iv) state references for all data.
(v) state all ssumptions and decisions.
(vi) quote absolute Pγ per decay.
(vii) quote uncertainties for all data at one standard deviation, uncertainties starting with a 1 or 2 - use 2 significant figures, otherwise (3 to 9) use 1 significant figure.

2.7 Rules for the evaluation of alpha particle decay data

Rules (i), (iv) - (vii) for Pγ apply to Pα.

When evaluating Eα, Rytz and Wapstra data will be used as reference.

Evaluated Pα will be used by the decay scheme evaluator.

2.8 Distribution of information about new data and revised data in the database

(Lemmel paper para. 5)

Add to the list:
- participants at this Specialists Meeting
- the NEA Data Bank
- CERN, JINR Dubna

3. International Database Newsletter

T.D. MacMahon, Ascot, proposes that IAEA-NDS issues a Newsletter, on a 6-monthly basis. This newsletter will include details of the ~300 nuclides to be evaluated, information from those who are carrying out evaluations, information about evaluations which have been submitted to IAEA-NDS and all information relevant to the development of the international database.

The Subgroup adjourned at ~16.00 hrs

Appendix 2

IAEA Specialists' Meeting on the Development of an International Nuclear Decay Data and Neutron Cross-Section Database

Report by

The Subgroup on Cross-Section Database

Members of the subgroup: H. Condé (Chairman)
F. De Corte
H.D. Lemmel (Secretary)
V.N. Manokhin
E. Menapace
H. Rauch
A. Simonits

1. Introduction

The subgroup met on Oct 25, 26 and 27.

The subgroup discussed the general need of an international thermal cross-section database for use in basic and applied nuclear research. It was concluded that at present there exists several national evaluated data libraries and various Wall Chart compilations that include thermal cross-section data which are not in agreement with each other. The lack of an internationally agreed database is very disturbing. It is realized that the Mughabghab book (ref. .....) had been used widely as a reference file for thermal cross-sections. The fact that this project is not being continued, was among the main reasons for organizing the present meeting to agree on the procedures for an international database for thermal cross-sections.

2. Definition of the data scope

It was concluded that the aim of the envisaged cooperation is to provide an internationally accepted database for

- Thermal cross-sections (2200 m/s and 20°C Maxw)
- Resonance integrals (cut-off 0.55 eV according to the EANDC definition)
- The effective resonance energy E_r (Ryves definition)
- Westcott g (T_n)-factors and s_0-factors
- Scattering lengths

3. Existing evaluations and publications

A survey was made of the existing data evaluations and measurements of relevance for the cross-section database. Short statements about the present status of the KORT library by Manokhin, the cross-section evaluation activities of the ENEA Scientific Data Programme for JEF by Menapace, the k_0 measurement activities at INW and KFKI by De Corte and A. Simonits and the compilation of experimental data for neutron scattering lengths by Rauch are given in Appendix I.

A list of publications, handbooks etc. covering relevant cross-section information was extracted from the Index of Nuclear Data Libraries available from the IAEA Nuclear Data Section (IAEA-NDS-7, March 1994) by H.D. Lemmel and is given in Appendix II. It was found that none of these databases (except one, see further below) is suitable to be internationally recommended, primarily due to the lack of uncertainty estimates and/or the lack of adequate documentation of the evaluation, so that significant analysis work is required for each nuclide, before a recommended value can be adopted.

4. Agreed evaluation and documentation procedures

The evaluation procedures proposed to the Subgroups by H.D. Lemmel including the need of proper documentations were adopted. The documentation is of great importance for future updates of the database. The procedures for supplementing and updating of the cross-section database should be similar to the flow-chart prepared by the decay data subgroup.

5. Nomination of group members

Within the cooperation outline given in the draft by Lemmel, the following groups should be set up:

A. *The approval group*

One member each from the

- ENDF/B cooperation
- JEF cooperation
- BROND cooperation
- CENDL cooperation
- JENDL cooperation
- a representative of the "k_0 library group" (De Corte, Simonits)
- plus one member from the INDC Standards Subcommittee.

IAEA/NDS will submit new evaluations to the members of this group. If no objection is received within 2 months, the new evaluation is considered as internationally agreed and it will be entered in the international database.

B. *The group of evaluators and reviewers*

Abagyan, Kurchatov Institute
Deruytter, Geel
Carlson, NIST
Feiner, USA
Gruppelaar, Petten
Holden, Brookhaven
Head, CNDC Beijing, or whom he nominates
Kikuchi, JAERI, or whom he nominates
Konieczny, Data Bank
Menapace, ENEABologna (or whom he nominates)
V.F. Sears, Chalk River
Tellier, France
Roussin, or another suitable member of CSEWG
plus volunteers who are willing to submit evaluations
according to the agreed procedures
others?

Above individuals will primarily be invited to submit evaluations or to review evaluations before they are submitted to the approval group. An assignment of specific responsibilities is not possible at the present. Evaluators are invited to announce their field of interest.

C. *The distribution list of the product (= "Recipients")*

See Lemmel's draft, some additional recipients to be added.

The coordinaton of the A and B group is recognized as the mandate of NDS with the advice and assistance by the Chairman of the INDC Standards Subcommittee.

Action on IAEA/NDS:
To send the Minutes of the present meeting to the above 3 groups and request their cooperation.

Action to all participants: to send additional names and addresses for these lists.

6. Relation to ENDF formatted databases

The originators and evaluators of ENDF formatted databases

BROND-2
CENDL-2
ENDF/B-6
JEF-2
JENDL-3.2

are invited to submit, for inclusion in the international database, those thermal cross-section evaluations

- which are original (and not taken over from older sources);
- which have an uncertainty analysis; and
- which are sufficiently well documented.

Actions: Specifically E. Menapace (together with Konieczny) with respect to JEF-2, and V. Manokhin with respect to BROND-2, are asked to review these databases and define thermal cross-section σ_0 evaluations that are suitable for input to the international database, together with the related computed values of σ (Maxw), g-factor and resonance integral.

Action on Lemmel, to bring the outcome of the meeting to the attention of the originators of CENDL-2, ENDF/B-6 and JENDL-3.2, who were not present at the meeting, and to ask them to extract suitable thermal cross-section evaluations from these files for submission to the international database cooperation, with adequate documentation.

If the international database adopts a new thermal cross-section evaluation, it can certainly not be expected that this will be in agreement with the 5 ENDF formatted data libraries. However, it is the wish of the present meeting, that the international agreed values should be considered for inclusion in the next update of these libraries.

7. Relation with other data libraries

Action on Manokhin to review the KORT library of thermal activation cross-sections and resonance integrals to see what evaluations in this library are sufficiently well documented and up-to-date to match the agreed evaluation standards, and to submit the evaluations that were selected in this way, for inclusion in the international database.

8. How to start and how to procede

It was agreed that the international database should not aim at completeness from the beginning. It should start with a very small file of data that can already now be considered as internationally agreed, i.e., those thermal cross-section data that exist in the NEANDC/INDC Standards File.

Additional evaluated data should be submitted according to the agreed procedures. When the international file is distributed, a note should be added saying that for all data that are not found in the present version of the international file, users are referred to the Mughabghab book as a preliminary solution (although it is known that not all data in this book can still be considered as up-to-date).

In the field of Scattering Lengths, the file by Koester and Rauch, ADNDT 49 (1991) is recommended for international use. Any proposals for updates that are found necessary, should be addressed to H. Rauch at the Atominstitut der Österreichischen Universitäten, Schüttelstrasse 115, A-1020 Vienna.

Action on H.D. Lemmel and H. Rauch to find means to make this file generally available through the IAEA/NDS online service.

9. Data evaluations priorities

Priority should be given to those nuclides that are important for practical applications, and to those nuclides where different databases, wallcharts, etc. contain discrepant values. Priority should also be given to those nuclides where the data in the Mughabghab handbook are outdated.

For priority lists defined earlier, attention is drawn to several IAEA meetings and the resulting INDC reports.

Areas of priority are, spcifically

- all thermal activation cross-sections used for
    - activation analysis
    - dosimetry
    - decommissioning
- thermal cross-sections of actinides, fission-products and burnable poisons used for
    - reactor neutronics calculations and safety
    - safeguards

In the course of development of spallation sources for transmutation and other applications, additional new data needs and accuracy requirements of thermal cross-sections will arise. In spallation facilities high fluxes of thermal neutrons will occur and used for material analysis and other applications so that a reliable database of thermal cross-sections and resonance-integrals with increased accuracies will be required. Data needs and accuracy requirements of such advanced applications should be studied in separate IAEA meetings.

To improve the thermal cross-section database, new measurements will be required in many cases. It was not the purpose of the present meeting to identify areas where insufficient data accuracies require new measurements. In view of data needs specified in earlier IAEA/NDS meetings it is felt that additional efforts, possibly through IAEA CRPs, will be needed to make the thermal cross-section database sufficiently accurate for applications.

Cross-section subgroup
Appendix 1

About the activity on thermal cross-sections in Russia

V.N. Manokhin

Mainly this activity is in the evaluation field. In 1988 a second version of KORT library was prepared. The library contains thermal cross-sections and resonance integrals for 343 stable nuclides. The description of the library was published in the journal VANT, Ser. Yadernye Konstanty, N4, 1989/L.P. Abagyan et al. Recently some revisions of KORT-88 are made and thermal cross-sections and resonance integrals for fissile nuclides are prepared. Besides in 1993 the thorough analysis on thermal cross-sections and resonance integral was made by T.S. Belanova for fissile nuclei from Pa up to Bk.

It is supposed to publish in Journal VANT, Ser. Yadernye Konstanty revised values of KORT library and the part of this library for fissile nuclei, the thermal cross-sections and resonance integrals of which were evaluated recently.

It is planned to send the whole KORT library into Nuclear Data Section as soon as the data will be formatted properly and checked.

The ENEA Scientific Data Programme for the JEF Library

E. Menapace

The activities on cross-section data evaluation, in the framework of ENEA Scientific Data Programme including Nuclear Data, are referred to the international collaboration for the development of JEF (NEA) and EFF Files and to ENEA-CEA cooperation. With respect to these activities, planned actions for new or improved evaluations, including thermal cross-sections and resonance integrals, concern (as proposed to the next JEF Meeting):

(i) structural materials, such as natural isotopes of Mg, Y, W, Nb with some additions from next EFF Meeeting (Dec. 1994);

(ii) burnable poisons, namely natural isotopes of Er and Hg;

(iii) specific long-lived fission products, mainly ^{129}I;

(iv) minor actinides, such as ^{237}Np, Am ^{241}Am and ^{243}Am.

Neutron scattering length

H. Rauch

The neutron scattering length provide a more detailed information about the low energy neutron-nuclei interaction. The values are of relevance for any structural and dynamic investigations of condensed matter and they are met by

crystallographers
biologists
structural chemists
material scientists

Neutron scattering length are essential for the development of new spectrometric methods like focussing, bunching by supermirrors, neutron guides multilayer systems etc. and for isotope matching in biological substances.

More accurate values are needed when new reactor and spallation based neutron sources come into operation. An update of existing data files send a cross check with cross section data is strongly recommended. The IAEA should encourage an update of existing data and should provide a system to distribute the information also to developing countries.

The existing data file has been published in Atomic Data and Nuclear Data Tables 49 (1991) 65 and is available as a computer file based on dBase III-Plus and Turbo Pascall compatible on a MS-DOS operating system. (Contact H. Rauch, Atominstitut der Österreichischen Universitäten, Schüttelstrasse 115, A-1020 Wien.)

From k_0 to reliable and consistent database of σ_0 and essential related activation and decay constants

F. De Corte and A. Simonits

k_0-Factors are composite nuclear constants containing molar masses (M), isotopic abundances (θ), absolute gamm-intensities (γ) and 2200 ms^{-1} (n,γ) cross sections (σ_0), also including these data for the ultimate comparator $^{197}Au(n,\gamma)^{198}Au$ [411.8 keV]. Precise and accurate k_0-values for [the most prominent gamma lines of] 122 (n,γ) rections were obtained as a result of measurements, mainly at the INW and the KFKI, via the activation method performed with various experimental setups (targets, reactors, Ge detectors, etc.).

Evidently, k_0's can easily be converted to corresponding σ_0's by introducing values for M, θ, γ and σ_0 for Au). With regard to the quality and applicability of the thus created σ_0 data set, it is strongly advisable that: i) the input for γ (and for θ, in case of less abundant isotopes) is based on an up-to-date and internationally recognized database; and ii) the final σ_0 data base contains (or at least refers to) the input data as well, in order to guarantee consistency and traceability.

A database of I_0 (resonance integrals) can be obtained from this set of σ_0's by combination with the set of Q_0-values (I_0/σ_0 ratios), which are input data when determining and applying k_0-factors (so as to take into account the contribution of epithermal activation) and which were experimentally measured at the INW and the KFKI using the Cd-ratio method. At present, some of the data in our Q_0-library do not originate from experimental determination at the INW/KFKI but are taken from former compilations (often containing conflicting data). Updating and extension is highly desirable.

Determination and application of Q_0 requires correction for a non-1/E epithermal neutron flux distribution, and this can be based on the concept of the $1/E^{1+\alpha}$ approximation and the effective resonance energy $\bar{E}_r$. The presently available INW/KFKI $\bar{E}_r$-library, as published in the 1987 IAEA Handbook on Nuclear Activation Data, was based on calculation using the resonance parameter data from BNL 1981/1984. For cases where these data were not available [e.g. $^{96}Ru(n,\gamma)$], a method was worked out for experimental $\bar{E}_r$ determination. In general, updating of the existing $\bar{E}_r$ data library is strongly advised and should be based on the most recent compilation of evaluated resonance parameter data.

Our existing database of σ_0 and essential related activation and decay constants (M, θ, γ, I_0 and $\bar{E}_r$) dates from the mid-80's and was mainly released as compilations published in the Journal of Radioanalytical and Nuclear Chemistry. Upgrading and extension can be performed as outlined above.

Cross-section subgroup
Appendix 2

Publication and data libraries on Thermal neutron cross-sections and resonance integrals

ENDF-formatted libraries: Recent values of thermal neutron cross-sections and resonance integrals are in the data libraries BROND-2, CENDL-2, ENDF/B-6, JEF-2, JENDL-3 where, however, these values must be computed with a computer code. For JENDL-3 these values are tabulated in the report JAERI-M-90-099 pages 461-486. For the JENDL-3 Fission Product Library see the report JAERI-M-92-077 pages 453-488.

A comparison of the numerical thermal data in JEF-2, ENDF/B-6, JENDL-3, CENDL-2 and BROND-2 is given in the JEF Report 14 (1994). - Without uncertainties!

Thermal neutron cross-sections and resonance-parameters:
See reports BNL-325 and the books "Neutron Cross-Sections" (Academic Press), Vol.1,

Part A for Z = 1-60 (1981)
Part B for Z = 61-105 (1984)

containing thermal neutron cross-sections and resonance parameters. These books are not available from IAEA, and the corresponding data are not available on magnetic tape. Of these books the thermal neutron cross-section and resonance-integral data are available online in NDIS within the **NUDAT** database which is described in chapter 20 of this document.

Neutron Resonance-Parameters from BNL-325, third edition, 1973. Available on tape in either standard format or edited format. Description of content and format: IAEA-NDS-28.

UENDL/NAA, U3SR Evaluated Nuclear Data Library for Neutron Activation Analysis. Contains activation cross-sections for thermal neutron capture and absorption reactions, resonance integrals and some other data. See under "Neutron Activation" for further details.

Gryntakis File 1986: Contains thermal activation cross-sections, resonance-integrals, main gamma-rays, half-lives, for all nuclides: IAEA-NDS-64. See also Handbook on Nuclear Activation Data, IAEA Technical Report Series No. 273, p. 199-260.

g-factors as function of temperature for non-1/v nuclides see E.M. Gryntakis, J.I. Kim, Radiochimica Acta 22 (1975) 128.
g-factors by N. Holdern, published recently in J. Pure and Appl. Chem.

KORT 1988: Thermal neutron cross-sections and resonance-integrals of elements and isotopes up to 83-Bi-209. See report INDC(CCP)-327.

Neutron Scattering Lengths, a compilation of experimental data and recommended values by L. Koester, H. Rauch, E. Seymann, published in Atomic Data and Nuclear Data Tables 49, 65-120, 1991. This is an update of the work first published under an IAEA contract in the report Jül-1755, Dec. 1981, now covering the literature up to the end of 1990. - A similar work was published earlier by V.F. Sears, report AECL-8490, June 1984. - For the 1981 version by Koester et al., see document IAEA-NDS-44, and a wall chart which was obtainable for 420.- Austrian Schillings from H. Bittermann, Atominstitut, Schüttelstraβe 115, A-1020 Wien. The 1991 version is available on tape (internal code: NEUTSCATL), with 2 parts: 1. experimental data; 2. recommended values. The files are based on dBaseIII-Plus and on Turbo Pascal and compatible with MS-DOS operating systems.

Appendix 3

IAEA Specialists' Meeting on the Development of an International Nuclear Decay Data and Cross-Section Database

Agenda and Schedule

Sessions: 09:00 to 17:30
coffee break 10:45 to 11:15
lunch break 13:00 to 14:30
coffee break 15:45 to 16:15

end: Friday noon

Note: The Cross-Section Subgroup meets in Room C-7-39 (Tuesday afternoon to Thursday)

Monday	09:00	1. Opening (C.L. Dunford) 2. Announcements 3. Election of chairman 4. History and objectives of the meeting (H.D. Lemmel) 5. Review of speakers' list 6. Presentation of papers
Tuesday	09:00	6. Presentation of papers (cont'd) 7. General discussion: What can be achieved at the meeting? 8. Formation of Subgroups, definition of the tasks of the subgroups 9. Subgroup Meetings
Wednesday	09:00	9. Subgroup Meetings (cont'd)
Thursday	09:00	9. Subgroup Meetings (cont'd) 10. Plenary: reports by subgroups 11. Conclusion
Friday	09:00-12:00	Approval of conclusions

Subgroups:

1. on half-lives and decay-data
2. on cross-section data (thermal cross-sections, γ-factors, resonance-integrals)

SCHEDULE

	Monday	Tuesday	Wednesday	Thursday	Friday
09:00	Opening	papers	subgroups	subgroups	approval of
10:45					
11:15	papers	general discussion	subgroups	reports by subgroups	conclusions
13:00					
	(1)		(4)		
14:30	papers	formation of subgroups	subgroups	conclusion	
15:45					
16:15	papers	subgroups	subgroups	conclusions	
17:30					
	(2)	(3)			

(1) special lunch in self service area of VIC cafetaria
(2) reception: snacks and drinks near meeting room
(3) reserved tables in town, to be announced
(4) no lunch service in VIC

Note: The Cross-Sections Subgroup meets in room C-76-39

Appendix 4

IAEA Specialists' Meeting on the
Development of an International Nuclear Decay Data
and Neutron Cross-Section Database
IAEA Headquarters, Vienna, 24-28 October 1994
Meeting Room V, Building C, 7th Floor

LIST OF PARTICIPANTS

AUSTRIA

H. Rauch
Atominstitut der Österreichischen Universitäten
Schüttelstrasse 115
A-1020 Wien
Tel.: +43 1-72701
Fax: +43 1-728-9220

G. Winkler
Institut für Radiumforschung und Kernphysik der Universität Wien
Boltzmanngasse 3
A-1090 Wien
Tel.: +43 1-313-67-3504
Fax: +43 1-313-67-3502
E-mail: IRK@AWIRAP

BELGIUM

F. De Corte
Instituut voor Nucleaire Wetenschappen
Proeftuinstraat 86
B-9000 Gent
Tel.: +32 0-9264-6627
Fax: +32 0-9264-6699

Denis De Frenne
Laboratorium voor Kernfysika
Proeftuinstraat 86
B-9000 Gent
Tel.: +32 0-9264-6532
Fax: +32 0-9264-6699
E-mail: INWFF@BGERUG51

FRANCE

M.S. Antony
Centre de Recherches Nucléaires
23, rue du Locss
F-67037 Strasbourg Cédex 2
Tel.: +33 88-106-597
Fax: +33 88-106-479

G. Audi
CSNSM, IN2P3-CNRS
Bâtiment 108
Université de Paris XI (Paris-Sud)
15 rue G. Clemenceau
F-91405 Orsay Campus
Tel.: +33 16-941-5223
Fax: +33 16-941-5268
E-mail: AUDI@FRCPN11.IN2P3.FR

M.M. Bé (Mme)
L.P.R.I.
Centre d'Etudes Nucléaires de Saclay
B.P. No. 52
F-91193 Gif-sur-Yvette
Tel.: +33 16-908-5288
Fax: +33 16-908-9529
E-mail: MMBE@VIOLETTE.CEA.FR or MMBE@BABAORUM.CEA.FR

O. Bersillon
CEN de Bruyères-le-Châtel
Service de Physique et Techniques
B.P. No. 12
F-91680 Bruyères-le-Châtel
Tel.: +33 16-926-5414
Fax: +33 16-926-6094
E-mail: BERSIL@BRUYERES.CEA.FR

N. Coursol (Mme)
L.P.R.I.
Centre d'Etudes Nucléaires de Saclay
B.P. No. 52
F-91193 Gif-sur-Yvette
Tel.: +33 16-908-5288
Fax: +33 16-908-9529
E-mail: COURSOL@BABAORUM.CEA.FR

HUNGARY
Gábor Molnár
Head, Department of Nuclear Physics
Institute of Isotopes
Hungarian Academy of Sciences
H-1525 Budapest, P.O.B. 77
Tel.: +36 11-694-99
Fax: +36 11-565-045
E-mail: MOLNAR@ISERV.IKI.KFKI.HU

András Simonits
Department of Nuclear Chemistry
KFKI - Atomic Energy Research Institute
Hungarian Academy of Sciences
P.O. Box 49
H-1525 Budapest 114
Fax: +36 11-552-530
E-mail: SIMONITS@FSERV.KFKI.HU

ITALY
Enzo Menapace
Head, Nuclear Data and Codes Laboratory
E.N.E.A. Centro Richerche
Energia "E. Clemental"
Viale Ercolani 8
I-40138 Bologna
Tel.: +39 51-498-329
Fax: +39 51-498-151
E-mail: #BENZO1@IBOENEA.BOLOGNA.ENEA.IT

RUSSIA
V.P. Chechev
V.G. Khlopin Radium Institute
28 Second Murinskiy Ave.
194 021 St. Petersburg
Tel.: +7 812-247-3706
Fax: +7 812-247-8095
E-mail: ARK@RI.SPB.SU
Note the changed Fax number

F.E. Chukreev
Institut Atomnoi Energii I.V. Kurchatova
46 Ulitsa Kurchatova
123182 Moscow
Fax: +7 095-943-0073
E-mail: CHUKREEV@CAJAD.KIAE.SU

T.V. Golashvili
Institute of Information
ATOMINFORM
P.O. Box 971
127434 Moscow
Tel.: +7 095-976-7286
Fax: +7 095-976-7203

V.N. Manokhin
Centr po Jadernym Dannym
Fiziko-Energeticheskij Institut
Ploschad Bondarenko
249 020 Obninsk, Kaluga Region
Fax: +7 095-883-3122
E-mail: MANOKHIN@CJD.OBNINSK.SU (new)

I.P. Selinov
Comm. for Numerical Data in Science
and Technology (CAEN)
The Russian Academy of Science
Leninskij Prospekt 14
Moscow V-71
Fax: +7 095-230-2420

Viktor A. Vukolov
Institut Atomnoi Energii I.V. Kurchatova
46 Ulitsa Kurchatova
123182 Moscow
Fax: +7 095-943-0073

SWEDEN
H. Condé
Dept. of Neutron Research
Uppsala University
P.O. Box 535
S-751 21 Uppsala
Tel.: +46 18-183-853
Fax: +46-18-183-833
E-mail: CONDE@TSL.UU.SE

UNITED KINGDOM
T.D. MacMahon
Imperial College
University of London
Silwood Park, Sunninghill
Ascot, Berkshire SL5 7TE
Tel.: +44 1344-294290
Fax: +44 1344-24931
E-mail: t.macmahon@ic.ac.uk

A.L. Nichols
AEA Technology
353 Harwell, Didcot
Oxfordshire OX11 0RA
Tel.: +44 1235-434-113
Fax: +44 1235-436-285
E-mail: ALAN.NICHOLS@AEA.ORGN.UK

Simon Woods
National Physical Laboratory
Division of Radiation Science & Acoustics
Buidling 56, Queens Road
Teddington, Middlesex TW11 0LW
Tel.: +44 181-943-6424 (direct)
Fax: +44 181-9436161

Note the changed area code in UK

UNITED STATES OF AMERICA

Edgardo Browne
Isotopes Project
Bldg. 50A, MS-6102
Lawrence Berkeley Laboratory
University of California
Berkeley, CA 94720
Tel.: +1 510-486-7647
Fax: +1 510-486-5757
E-mail: EBROWNE@CSA3.LBL.GOV

Frank Feiner
Knolls Atomic Power Laboratory
Bldg. F, Room 20, P.O. Box 1072
Schenectady, N.Y. 12301
Tel.: +1 518-395-4611
Fax: +1 518-395-7592

Richard G. Helmer
Idaho National Engineering Laboratory
E.G. & G. Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415-211
Tel.: +1 208-526-4157
Fax: +1 208-526-9267

Richard A. Meyer (Part time)
ER-23 GTN
Division of Nuclear Physics
U.S. Department of Energy
Washington, D.C. 20585
Tel. +1 301-903-3833
Fax: +1 301-903-3613
E-mail: U7552RM@DOEER
U7552RM@VM1.HQADMIN.DOE.GOV

F.J. Schima
Bldg. 245, Room C-114
National Istitute for Standards and Technology
Gaithersburg, MD 20899-0001
Tel.: +1 301-975-5537
Fax: +1 301-926-7416
E-mail: SCHIMA@ENH.NIST.GOV

INTERNATIONAL ORGANIZATIONS

IRMM/Geel

G. Bortels
Institute for Reference Materials
and Measurements
Steenweg naar Retie
B-2440 Geel, Belgium
Fax: +32 0-14-584-273

OECD/NEA

M. Konieczny
OECD/NEA
Le Seine St. Germain
12, blvd. des Iles
F-92130 Issy-les-Moulineaux, France
Tel.: +33 1-4524-1085
Fax: +33 1-4524-1110
E-mail: KONIECZN@NEA.FR

C. Nordborg
OECD/NEA
Le Seine St. Germain
12, blvd. des Iles
F-92130 Issy-les-Moulineaux, France
Tel.: +33 1-4524-1092
Fax: +33 1-4524-1110
E-mail: NORDBORG@NEA.FR

IAEA

C.L. Dunford (Head)
IAEA Nuclear Data Section
Wagramerstr. 5, P.O. Box 100
A-1400 Vienna, Austria
Tel.: 43-1-2360-1709
Fax: 43-1-234564
E-mail: DUNFORD@IAEAND.IAEA.OR.AT

H.D. Lemmel (Scientific Secretary)
IAEA Nuclear Data Section
Room A2320, ext. 1717

Part time (Nuclear Data Section):
S. Ganesan **A. Pashchenko**
N.P. Kocherov **O. Schwerer**
P. Obložinský **H. Wienke**
V. Osorio (Physics Section)

Nuclear Data Section
International Atomic Energy Agency
P.O. Box 100
A-1400 Vienna
Austria

e-mail, INTERNET: SERVICES@IAEAND.IAEA.OR.AT
e-mail, BITNET: RNDS@IAEA1
fax: (43-1) 20607
cable: INATOM VIENNA
telex: 1-12645 atom a
telephone: (43-1) 2060-21710

online: TELNET or FTP: IAEAND.IAEA.OR.AT
username: IAEANDS for interactive Nuclear Data Information System
username: NDSOPEN for FTP file transfer