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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

SUMMARY REPORT

SPECIALISTS' MEETING ON NUCLEAR DATA FOR APPLICATIONS

Vienna, 29 April - 3 May 1974

Edited by A. Lorenz
Nuclear Data Section

International Atomic Energy Agency
Vienna, Austria

Vienna, September 1974

IAEA NUCLEAR DATA SECTION, KÄRNTNER RING 11, A-1010 VIENNA

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FOREWORD

This meeting, recommended by the International Nuclear Data Committee (INDC) at its Sixth meeting in October 1973, had as its primary objective the convening of representatives of major data centres and groups dealing with the compilation and evaluation of nuclear level structure and decay data in order to work out the necessary measures for an extended international co-operation in the compilation, evaluation, exchange and dissemination of these data.

The expansion of the Agency's nuclear data programme, which so far has dealt primarily with neutron nuclear data, is based on the following earlier development:

The interest of the International Atomic Energy Agency (IAEA) in nuclear data started in the early sixties with the establishment of the International Nuclear Data Scientific Working Group (INDSWG), which was later consolidated as a continuing advisory body with the name International Nuclear Data Committee (INDC). Upon recommendation of INDSWG, the Nuclear Data Section (NDS) was formed in 1964; it implements the nuclear data programme of the IAEA and also acts as secretariat of the INDC.

Since then, the activities of the Section have been mostly related to neutron data whose compilation and evaluation are essential to fission reactor design and development. International co-operation was successfully established and has led to the present fully operational Four Neutron Data Centres network*.

During the same period, the application of nuclear techniques has witnessed a tremendous development in many fields of science and technology. This development requires many more nuclear data, in particular non-neutron

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*National Neutron Cross Section Centre (NNCSC) at Brookhaven, USA;
NEA Centre de Compilation de Données Neutroniques (CCDN) at Saclay, France;
Centr po Jadernym Dannym (CJD) at FEI, Obninsk, USSR:
IAEA Nuclear Data Section (NDS) in Vienna, Austria.

nuclear data. The general situation in this field was first surveyed in 1970 by an Agency Consultants' Meeting which led to the creation in 1972 of the International Working Group on Nuclear Structure and Reaction Data (IWGNSRD). This working group was efficient in assessing data needs in various fields of applications, in reviewing the existing compilation and evaluation activities, and in assisting the Agency in the preparation of the Symposium on Applications of Nuclear Data in Science and Technology which was convened in Paris in March 1973. The Symposium demonstrated, among other things, the broadened requirements of nuclear data users and the need for an increased support of the compilation and evaluation of basic non-neutron nuclear data, in order to satisfy these requirements. The administrative and policy functions of the IWGNSRD, now dissolved, have been transferred to INDC, and its more technical responsibilities to various specialized groups such as those convened for this meeting, and for the Consultants' Meeting on Charged Particle and Photonuclear Reaction Data, held in Vienna, 24 - 26 April 1974 (see INDC(NDS)-59/W).

This summary report consists of two parts. The first part, which embodies the actual summary of the meeting, consists of the Definition of Terms (reflecting the terminology as used at the meeting), the Status and Conclusions (summarizing the current situation in the field of nuclear level structure and decay data, and providing the background to the recommendations), and the Recommendations themselves, formulated by the meeting participants. The second part includes the adopted agenda, the list of participants, and the list of reports presented at the Meeting (published in their entirety in INDC(NDS)-61.)

Although treated separately at two different meetings, charged particle and photonuclear reaction data (discussed at the preceeding consultants' meeting and reported in INDC(NDS)-59/W), and nuclear level structure and decay data (subject of this summary report) together form the body of data which has been commonly referred to as non-neutron nuclear data. Recommendations from both meetings should therefore be considered together as the basis for the establishment of a system of international co-operation in the field of non-neutron nuclear data.

I. DEFINITIONS OF TERMS

The definitions given below fall into two separate categories: general and specific. Specific definitions are limited to the subject matter of this report. Thus "nuclear data", which would actually include nuclear reaction data and their associated parameter in a more general definition, is here defined in context of the scope of this meeting.

Nuclear Data (specific definition): numerical values of nuclear level structure and decay parameters and associated atomic parameters of pertinence to nuclear techniques and methods.

Mass-chain Nuclear Data (specific definition): nuclear data for all nuclides with a given mass number.

Tabulation (general definition): systematic collection and transcription of numerical information without critical selection or manipulation.

Compilation (general definition): systematic collection and transcription of all available information on a given subject with collation and re-organization for optimal presentation to the users.

Horizontal Compilation (specific definition): compilation of data on a particular nuclear property or properties over a range of nuclides.

Evaluation (general definition): critical appraisal of all available information compiled on a given subject and derivation of consistant best or preferred values with an estimate of their uncertainties, using critical selection, averaging, examination of correlation between different quantities and subjective judgement.

In-depth Evaluation (specific definition): critical appraisal of specific nuclear data parameters of one or more nuclides with the object to arrive at consistent best values of their properties together with a statement of their uncertainties and a detailed exposition of the analysis employed in the evaluation.

II. STATUS AND CONCLUSIONS

Introduction

Owing to the large-scale development of nuclear energy and to the increasing number of sophistication of nuclear methods and techniques in many fields of science and technology, the use of basic nuclear data is rapidly expanding on a world-wide basis. The present and near future needs for these data have been documented[1], and are illustrated in the Appendix of this report.

Currently, the processing of large amounts of nuclear data falls short of continuously growing requirements. This is the conclusion of both the International Nuclear Data Committee (INDC)* and the International Working Group for Nuclear Structure and Reaction Data (IWGNSRD), who recently surveyed the situation. To be useful it is absolutely necessary that these data be continuously compiled, evaluated, and made available to the users in convenient format and in good time. These general observations and conclusions formed the premise of the deliberations and recommendations of this meeting.

While the participants adknowledged the high standards and competence of existing cimpilation and evaluation groups, and while they recognized the futility of trying to satisfy the almost insatiable requirement among users for ever-more complete and up-to-date compilations, they nevertheless concluded that the short and long-term requirements of the vast and diverse community of nuclear data users in science and technology cannot be met satisfactorily by the existing nuclear data compilation and evaluation centres and groups, or by existing publications of nuclear data tabulations and compilations in scientific journals and handbooks which are partially incomplete or outdated. The participants therefore consider it of prime

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1. Proceedings of the IAEA Symposium on Nuclear Data in Science and Technology, Paris, March 1973, see also report INDC(NDS)-46/U+W, 1972.

* The INDC is a continuing Committee of the IAEA, which serves to promote international co-operation in all phases of nuclear data activities, and to advise the Director General of the IAEA in this field.

importance to extend the existing compilation and evaluation efforts and co-operative links to an effecient and coherent network of international co-operation in order to improve the services to the users. This system should be based on the free international exchange of experimental as well as evaluated nuclear data.

The following objectives should form the basis for the organization and implementation of the proposed system:

- the adoption of a universal bibliographic reference system,
- the intensification or extension of the compilation and evaluation of basic nuclear data,
- the promotion and co-ordination of horizontal compilations and evaluations,
- the development of an international computerized file of evaluation nuclear data,
- the establishment of an international network for the dissemination of nuclear data,
- the establishment of a central information office, and
- the implementation of an organized effort to identify current requirements for nuclear data compilations and evaluations.

Recognizing that a number of basic components of this system already exist, the participants emphasized that the additional expenditure required is very modest compared to costs of basic physics research[1] and documentation systems, and would be fully justified by the benefits to the user community.

The participants were cognizant of the fact that of the whole community of compilers and evaluators, not all major nuclear data centres and groups, were present. They therefore do not claim completeness regarding the content of this background status report, nor do they imply any commitment on the part of centres, groups or individuals present or not present at the meeting.

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1. In this regard it is interesting to quote the authors of the Keynote Address to the IAEA Symposium on Nuclear Data in Science and Technology (Proceedings, Volume 1, page 3), that the cost of compiling a given datum by the Nuclear Data Project is approximately one percent of the cost of its production.

A. References

A complete and up-to-date file of bibliographic references is the basis of any system of data compilation and evaluation. The development of a world-wide nuclear data compilation and dissemination system should therefore start with a universal bibliographic reference file. To be effective, such a file should be updated with new reference material with the shortest possible delay.

Furthermore, it is desirable that all centres, groups and individuals participating in this system adopt a universal system of keywords to aid in the indexing and exchange of all bibliographic and reference information. In this regard, the nuclear data reference file and keyword system of the Oak Ridge Nuclear Data Project are currently recognized to be the most complete and adequate referencing system available. The participants noted that some intercentre co-operation has recently been started inasmuch as the Nuclear Data Centre of the Leningrad Institute of Nuclear Physics, at Gatchina, and the Centre of the State Committee on the Utilization of Atomic Energy for Data on Nuclear Structure and Nuclear Reactions at the Kurchatov Institute in Moscow have recently adopted the reference and keyword system of the Oak Ridge Nuclear Data Project.

B. Compilation and Evaluation of Basic Mass-chain Nuclear Data

The compilation and evaluation of mass- or A-chain nuclear data is currently being performed in a co-ordinated manner with a minimum amount of duplication by several groups.

The groups and centres contributing to this effort are those of W.E. Meyerhof at Stanford University in California and T.A. Tombrello at the California Institute of Technology (covering $A<5$), F. Ajzenberg-Selove at the University of Pennsylvania and (the late) T. Lauritzen at the California Institute of Technology (covering $5\leq A\leq 20$), P.M. Endt and C. van der Leun at the Utrecht University (covering $21\leq A\leq 44$) and the Nuclear Data Project at Oak Ridge (covering $A\geq 45$). The results of these efforts are published in the Nuclear Data Sheets and Nuclear Physics in the form of separate independent mass-chain compilations.

In addition, the Table of Isotopes Project of the University of California at Berkeley in the United States, making extensive use of the current mass-chain compilations and evaluations of the above centres and

groups, publishes from time to time a concise compilation of evaluated data on radioisotope and nuclear level properties for all mass-chains, which is universally recognized as a basic compact reference[1]. Furthermore, there are a number of other groups and individuals, such as B.S. Dzhelepov, L.K. Peker, I.P. Selinov and many other scientists in the Soviet Union as well as in other countries, who have performed independent major compilations and evaluations of mass-chain nuclear data and whose works are published in separate monographs[2, 3].

In all cases, extensive use has been made, and is currently being made, of the compilations and evaluations published by these centres, groups and individual scientists (e.g. Nuclear Data Sheets, Table of Isotopes, Decay Schemes of Radioactive Nuclides, etc.) by fundamental and applied users, as well as by numerous other compilation groups (such as groups compiling Charts of the Nuclides), who select and repackage the basic data in a form best suited for their application.

Although the basic nuclear data centres and groups provide in principle a solid base for the most widely used data, it is recognized that this base lacks up-to-dateness and completeness. Specifically, the current compilation effort, as described above, does not meet the requirement of an efficient turn-around time in the update of these data, which at present is of the order of six to eight years. The deficiencies of the current compilation and evaluation effort, which are manifested by the unavailability of up-to-date and complete compilations have been the cause of frequent and unnecessary duplications of secondary or "repackaged" compilations such as those of gamma-ray spectral data.

The participants conceive of two possible solutions which could improve this situation: an intensification of the existing efforts in the compilation and evaluation of basic mass-chain data, or the creation of new compilation and evaluation groups. With regard to the latter, they recognize a growing interest displayed at this meeting to set up national groups in some of the Agency's Member States (e.g. UK, Australia, Sweden, India,

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1. Table of Isotopes (Sixth Edition), C.M. Lederer, J.M. Hollander and I. Perlman, John Wiley and Sons (1967).
2. Decay Schemes of Radioactive Nuclei, B.S. Dzhelepov, L.K. Peker and V.O. Sergeev, Nauka, Moscow (1963, 1966).
3. Isotopes, I.P. Selinov, Nauka, Moscow (1970).

Romania, Yugoslavia, etc.) for compiling nuclear structure and decay data, in response to their national nuclear data requirements, which in their opinion cannot satisfactorily be met by the existing nuclear data publications and services.

C. Compilation and Evaluations of Selected Nuclear Data

Two specific types of specialized compilations and evaluations are recognized:

(a) "In-depth" evaluations, and

(b) "Horizontal" compilations and evaluations.

One example of "in-depth" evaluation is the "Critical Evaluations of Decay Properties"[1] performed by the Euratom Working Group* for the ionizing radiation metrology institutions in the EURATOM area and for radionuclide users in many other fields.

"Horizontal" compilations are used extensively by numerous users in applied fields as well as in fundamental nuclear physics. Examples of such compilations are: the various existing Charts of the Nuclides[2], the H.J. Martin and P.H. Blichert-Toft compilations of radioactive isotope properties for medical use[3], the Catalogue and Recommended Alpha Energy and Intensity values by A. Rytz[4], Strengths of Gamma-ray Transitions Between Bound States of A = 2 - 44 Nuclei, by P.M. Endt and C. van der Leun[5], etc. These types of compilations rely heavily on the basic mass-chain compilations, and are thus dependent on their up-to-dateness and completeness. Currently, plans to perform various "horizontal" compilations exist also in smaller countries in response to specific scientific and applied needs.

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1. Atomic Energy Review, Vol. II, No. 3 (1973).

* The Euratom Group is composed of groups and individual scientists at the Laboratoire de Métrologie des Rayonnements Ionizants (LMRI) of the Centre d'Études Nucléaires at Saclay, France, the Netherlands Institute for Nuclear Research (IKO) at Amsterdam, the Physikalisch-Technische Bundesanstalt (PTB) at Braunschweig in the Fed. Rep. of Germany and the Bureau Central des Mesures Nucléaires (BCMN) of EURATOM at Geel, Belgium.

2. Chart of the Nuclides (11th Edition), N.E. Holden and F.Wm. Walker, Knolls Atomic Power Laboratory (1972); Nuklidkarte (3rd Edition), W. Seelmann-Eggebert, S. Pfennig and H. Münzel, Institut für Radiochemie, Kernforschungzentrum, Karlsruhe (1968).

3. Nuclear Data A8, 1 (1970).

4. Atomic Data and Nuclear Data Tables 12, No. 5 (1973).

5. Atomic Data and Nuclear Data Tables 13, No. 1 (1974).

D. International Computerized File of Evaluated Nuclear Data

The compilations and evaluations of basic nuclear data (i.e. mass-chain compilations and evaluations) and compilations of selected nuclear data (i.e. "in-depth" and "horizontal" compilations and evaluations) provide the fundamental and applied users with a vast amount of nuclear data in the form of diverse publications. Although apparently satisfying most of the needs of fundamental users, the current system of nuclear data compilation, evaluation and dissemination has not proven to be adequate for most users in applied fields of nuclear science and technology.

The deficiencies of the current situation of concern here, are as follows:

- the available data information is incomplete and not as up-to-date as required,
- the data are dispersed in many publications,
- different publications contain different values for the same parameters,
- best or recommended values are often not given,
- the published data are mostly not qualified by uncertainty estimates,
- data are not available on computer media, such as computer print-out or magnetic tape or disc,
- data and information sources are not known, or are not accessible,
- no nuclear data computer storage, retrieval and dissemination systems exist.

It is evident that there is a definite need for a universal standardized source of nuclear data which would rectify these deficiencies. The participants see a solution in the development of an international computerized file of evaluated nuclear data. Although initially, such a file will be used primarily by the nuclear physicists, it is envisaged that, as the needs of the applied users are defined and taken into account, this file will undoubtedly be a significant asset to the international community of applied users in science and technology.

It would not be in the interest of IAEA Member States, and it cannot be expected that one country, without an adequate return from the outside, undertake the development and distribution of such a file on its own resources. As a consequence, it is evident to the participants that the

efforts towards the development of such a file should be shared on an international level and, that the data which are to form its content should be compiled, co-ordinated, updated, exchanged and disseminated in a continuous co-operation between the existing and new nuclear data compilation and evaluation centres and groups.

In the process of establishing this international system, a number of technical and communication problems will necessarily arise. These will have to be dealt with by specialized meetings, discussions and agreements between compilers and programmers from all centres and groups concerned. The feasibility of such an international co-operation has been demonstrated by the existing, efficiently functioning co-operation of the four regional neutron data centres* in the compilation and exchange of neutron nuclear data.

While the participants recognize that such an international system should be designed so that a turn-around time in the update of the basic evaluated nuclear data be significantly shorter than at present, they urge that the system be flexible and responsive to changes in priorities in applied user requirements, as well as to changes in trends of basic nuclear research (e.g. development of heavy ion research).

E. Dissemination of Nuclear Data

Currently, the dissemination of nuclear data from compilers and evaluators to the users proceeds primarily through the medium of formal publications (e.g. Nuclear Data Sheets, Table of Isotopes, Decay Schemes of Radioactive Nuclides, etc.). In a few of the established nuclear data centers (e.g. the Oak Ridge Nuclear Data Project , and the Nuclear Data Centre at the Kurchatov Institute), direct customer service is provided to nuclear data users.

Even if considered to be inadequate because of the lack of up-to-dateness and completeness, the dissemination of nuclear data through the medium of publications is recognized and relied upon by the scientific community. The introduction of an international system of nuclear data compilation, evaluation and dissemination should certainly not have an effect to de-emphasize this existing mode of information dissemination, but should serve as a necessary adjunct to it.

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* The NEA Neutron Data Compilation Centre, at Saclay (France), the USSR Centre for Nuclear Data, at Obninsk (USSR), the National Neutron Cross Section Center, at Brookhaven (USA), and the IAEA Nuclear Data Section in Vienna (Austria).

The international system, once established, will need an efficient world-wide network for the dissemination of these nuclear data. An international dissemination network of neutron nuclear data already exists*, and could serve as a model for the dissemination of nuclear structure and decay data such as the international evaluated nuclear data file.

Smaller national nuclear data centres could serve to complement the international network. There are plans in smaller countries to develop such centres and to establish nuclear data committees to function as local co-ordination and service organs, and to disseminate to users in their countries nuclear data information available from the larger nuclear data centres.

F. International Co-ordination

A major difficulty enccuntered by the nuclear data users, particularly in applied fields far removed from nuclear science, is that they do not know what information is available, and where to find it; often, they may not even be aware of the existence of data which could serve their purposes. To aid these users, as well as all other more informed users, the participants consider it highly desirable to establish a central office for the dissemination of information about the sources and availability of nuclear data.

The major initial activities of such a central information office would be to keep the community of data users informed of the availability of published and computerized nuclear data tabulations, compilations and evaluations, and to keep abreast of the needs and developments in the nuclear data field. In order to maximize its effectiveness, the centre would be expected to be kept fully informed of all compilation and evaluation activities.

G. Nuclear Data Requirements

The primary responsibility of an international nuclear data system should be towards the data users. In order to ascertain that their needs are met, the users have to be identified and their requirements determined. These would in turn form the main basis for the scope and content of the international computerized file of evaluated nuclear data.

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* See footnote on page 10.

A number of steps have already been taken in this regard. In 1973, the International Nuclear Data Committee (INDC) has formed two sub-sommittees, one on energy and the other on non-energy applications of nuclear data, whose main tasks are the assessment of nuclear data requirements in science and technology and the monitoring of the interface between users and producers of nuclear data.

To assist these two INDC sub-committees, the IAEA Nuclear Data Section was requested by the INDC to prepare a questionnaire directed to nuclear data users and to perform a world-wide survey of nuclear data requirements for nuclear and associated atomic data in the energy and non-energy areas of nuclear science and technology. The information obtained in response to this questionnaire should be of help in identifying the nuclear data users, in assessing the types of nuclear data needed, and in establishing the priorities for their requirements. It is also intended to solicit from the user community critical comments on the adequacy of existing nuclear data compilations and suggestions as to their possible improvements.

Also in response to recommendations of the INDC, the IAEA Nuclear Data Section has developed request lists for specific nuclear data needed in selected fields of application (i.e. reactors, safeguards, and fusion research) which it publishes regularly. Within the activity scope of the IAEA, the Nuclear Data Section convenes specialists' meetings on broad fields of nuclear data and their applications with the aim to ascertain the needs for further compilations, evaluations, or experimental work.

The result of all these surveys should serve to determine the actual scope and content of the international evaluated nuclear data file and the international compilation and evaluation effort required.

The participants acknowledged the intention of the INDC to investigate and monitor the long-term developments in nuclear science and technology, and to provide timely guidance and support for the required nuclear data compilation and evaluation efforts. They would be appreciative of any assistance that INDC members could render in stimulating the needed national support to fund the compilation and evaluation work required.

H. Acknowledgement and General Conclusions

The participants acknowledge the recommendation of the INDC to the IAEA to convene this meeting with the mandate to extend the international co-ordination of compilation, evaluation and exchange of nuclear data for applied purposes, and express their appreciation to the IAEA and its Nuclear Data Section for all steps they have taken in the past in this regard.

As regards the present situation, the participants want to emphasize that the existing compilation centres and groups dealing with nuclear data and their bibliographic references provide very valuable services, which could be usefully extended by means of international co-operation.

In order to ensure continuity and completeness of the overall compilation and evaluation work, and to maximize the benefit of the proposed international co-operation to the entire user community in science and technology, the participants are most strongly concerned that every effort be made to distribute the workload, and to design the system of co-operation in such a way as to guarantee and optimize the uniformity, scientific quality and up-to-dateness of the proposed compilations and evaluations, and make the following detailed recommendations.

III. RECOMMENDATIONS

A. References

1. All nuclear data centres and groups participating in and contributing to the international system of co-operation in the compilation and evaluation of nuclear data should consider adopting the Oak Ridge Nuclear Data Project bibliographic keywords and reference system, and building on the expertise developed by the Nuclear Data Project. It is furthermore recommended that these centres and groups be supplied with the bibliographic keywords and the reference master file of the Nuclear Data Project.

B. Mass-chain Compilations and Evaluations

1. In order to ensure continuity of the mass-chain compilation and evaluation efforts, the national authorities and international organizations concerned should give strong support to the existing nuclear data centres engaged in mass-chain compilations and evaluations and to those new groups which may be interested in contributing to the existing international effort of mass-chain compilation and evaluation.

2. The communication between the existing compilation centres should be strengthened. New groups should make maximum use of the scientific experience developed by the existing compilation and evaluation centres in close consultation with them. The participants also feel strongly that any new groups should be closely associated with experimental nuclear physics laboratories, as is the case for most existing groups.

3. The IAEA Nuclear Data Section should be available to assist in co-ordinating the working programmes of new and existing nuclear data compilation and evaluation centres and groups.

4. The IAEA should give serious consideration to include in their fellowship programme the training of new nuclear data compilers at the major existing centres, and also to convene training courses or seminars on nuclear data compilation and evaluation given by experts in the field.

5. The frequency of publication of mass-chain compilations and evaluations should be substantially increased.

C. Compilations and Evaluations of Selected Nuclear Data

1. Existing activities in the compilation and evaluation of selected nuclear data should continue to be supported by national authorities and international organizations for the benefit of applied and other users.

2. Scientists and groups interested in participating in compilation and evaluation work should be encouraged to perform such work in close communication with the existing groups with the objective of having a co-ordinated effort and drawing upon available experience.

3. The INDC should ascertain the need for compilations and evaluations of selected nuclear data. In response to specific recommendations of the INDC, the IAEA Nuclear Data Section should promote work on such compilations and evaluations in smaller countries in co-operation with nuclear data centres and committees in these countries.

D. International File of Evaluated Nuclear Data

1. An international computerized file of evaluated nuclear data required to satisfy the needs of applied and other users should be established as soon as possible.

2. The general requirement for this file would be that it contain single recommended values together with estimates of their uncertainties. The data scope of this file should be based on the nuclear data requirements of applied and other users as determined by the INDC. In establishing this file strong consideration should be given to studying and employing already widely used computer formats for nuclear data.

3. The co-ordination of the work to create this file, between existing and new compilation centres and groups, should be effected in such a way as to guarantee the speedy updating of this file as frequently as required by the development of applied user needs as well as by the progress and needs in nuclear physics research.

4. In order to ensure the feasibility of establishing such a file, the national authorities should guarantee a free exchange of pertinent experimental data and associated physics information to take place between nuclear researchers and data centres and groups, and between data centres and groups on an international scale.

5. This file should be made available to all interested data centres of the world for the dissemination of its contents to the entire nuclear community, and its availability be widely advertised by these centres.

E. Dissemination

1. In view of the growth of compilation and evaluation activities and with recognition of the information gap between the various data centres and the community of applied users, a Central Information Office should be established for the purpose of performing such functions as:

- maintaining and disseminating a catalogue of existing, projected and required compilations and evaluations,
- maintaining a list of existing nuclear data centres, compilers and other experts in nuclear data,
- answering requests from users on the source and availability of nuclear data compilations and evaluations,
- assisting in the co-ordination of the compilation and evaluation effort for the international file of evaluated nuclear data, and
- collection and disseminating information on the needs for nuclear data, with the objective of promoting compilation and evaluation work as need arises.

2. Such an office could be operated on a modest scale and its function be re-evaluated at some future time.

3. In order to reach the largest possible fraction of the community of users it would be necessary for this information office to advertise its services through all available channels (e.g. INDC members and liaison officers, professional journals and associations, and national nuclear data committees).

4. In order to assure the efficient operation of such an information office, all nuclear data compilation and evaluation centres and groups should communicate to it on a regular basis all developments (i.e. news, inovations, changes, etc.) in the field of nuclear data compilation and evaluation.

5. The IAEA should provide for establishing this office within its Nuclear Data Section under the aegis of INDC. The natural location for such an office is believed to be the IAEA Nuclear Data Section because of its connection with a wide variety of nuclear data users associated with IAEA programmes.

6. The IAEA should continue to publish compilations and evaluations of selected nuclear data of importance to applied users in its Atomic Energy Review and other IAEA publications.

7. The INDC should be asked to recirculate to the editors of relevant journals in which papers containing nuclear data are published, the "Recommendations to Editors of Nuclear Physics Journals" issued by the Agency's previous International Working Group on Nuclear Structure and Reaction Data (IWGNSRD) in 1972, and to request editors to ensure that these recommendations be included in the journals' instructions to authors and be circulated to the journals' referees.

F. Implementation

1. The participants ask the Director General of the IAEA, after consultation with the INDC, to take the necessary steps in order to implement these recommendations and to communicate them to the national authorities of all pertinent Member States and to international organizations. They are concerned that the Governments approached recognize the importance and urgency of these problems and give early and serious consideration to adequately support compilation and evaluation work in their countries in line with the suggested international co-operation and inform the IAEA of the steps taken.

2. The participants ask the Director General of the IAEA to bring the conclusions and recommendations of this meeting to the attention of other UN organizations, national and international professional societies and organizations, and academies of sciences, and to solicit their support for the actions proposed by this meeting. The assistance of INDC members and liaison officers in approaching these organizations would be helpful.

3. Depending upon the response of the Governments to the IAEA, future meetings necessary for the implementation of the proposed system of international co-operation should be convened by the IAEA Nuclear Data Section within the next year, on the following subjects:

- the international file of evaluated nuclear data, its form and content,
- in-depth evaluations, their common evaluation rules and co-ordination,
- compilation of selected nuclear data, their co-ordination and their contribution to the international effort.

Furthermore, the IAEA is asked to consider convening small specialists' meetings on nuclear data topics in conjunction with, and in close proximity in time and place to, topical panels, symposia, and conferences.

APPENDIX

PRESENT AND NEAR-FUTURE NEEDS FOR NUCLEAR LEVEL STRUCTURE AND DECAY DATA

Fields and Subfields of Applications	Methods and Techniques	Nuclear Data needed	Examples of most important isotopes	Comments	References
Fission Reactor Technology	**Neutron Cross Section evaluation**				
Nuclear reactor analysis and design	- Optical Model calculations - Statistical Model calculations	Nuclear level schemes: level energies, spins, parities, isotopic spins, deformation parameters	Structural material isotopes: Al,Si,Ca, Ti,V,Cr,Mn,Fe,Ni,Cu, Zr,Nb,Mo,Ta,W and Pb	CSEWG Recommendation on compilation of Nuclear Structure Data (June1971)	Private Comm. Drake M., 1971
	- Statistical Model calculations of $\sigma(n,\gamma)$, $\sigma(n,2n)$, $\sigma(n,p)$, $\sigma(n,\alpha)$, etc. ..	Nuclear masses, reaction Q-values, neutron binding energies, level density parameters, nuclear level structure data.	Structural material isotopes,+ isotopes produced by neutron induced fission	"	"
	- Calculation of neutron-induced gamma-rays, and secondary gamma-ray spectra, $d\sigma(n,x\gamma)(E_\gamma)/d\Omega$	Nuclear level schemes, level decay modes, branching ratios, multipolarity of photons mixing ratios, total and partial level widths, internal conversion coefficients	-Light element isotopes He,Li,Be,B,C, N,O,Na and Mg. -Structural material isotopes(see above) -Heavy isotopes: U235,U238,Pu239, Pu 240,Pu241,Pu242	"	"
Radiation Detection Dosimetry	- Evaluation of activation cross section and resultant decay chain data.	-Nuclear masses, reaction Q-values, -isotope decay data: energies, branching ratios vs.excitation energies, half-lives,etc	Isotope used in dosimetry detectors and foils	"	"
In-pile neutron flux monitoring	- Evaluation of thermal and resonance cross sections	-Lifetime and decay scheme data for the product nuclei	Na,Mn,Cu,Rh^{103},V, Dy,Lu^{176},W^{177}, Ag, Pt,Au. Ni,Al,Fe,Cd,U^{235}, U^{238},Pu^{239}		Private Comm. V.M. Kulakov and V.P. Rudakov, 1971
	- Evaluation of threshold neutron activation cross sections	-Lifetime and decay scheme data of product nuclei	P,S,Al,Mg,Fe		"
Fusion Reaction Technology					
See Fusion Nuclear Data Request List (INDC(NDS)-57/U)					
Nuclear Materials Safeguards					
Non-destructive testing	- γ-ray resonance Fluorescence	Nuclear structure and decay data (level energies,spin moments)	Fissile materials ($\sim$ MeV range)	Data insufficiently known	Paris 73,1,197 (Weitkamp)
	- Neutron-capture γ spectroscopy	Gamma-ray spectra (E_γ, I_γ ...)	Fissile materials		
	- α-spectroscopy	$T_{1/2}$, (and decay scheme)	Pu^{238}, Pu^{239}	Standardization needed	"
	- Calorimetry	Decay heat, decay energies	Pu isotopes		
	- Thermal neutron interrogation	Reaction data, resonance self-shielding	Fissile and fertile isotopes	accurate nuclear data required to apply proper corrections to relative measurements	"
	- Activation analysis	$T_{1/2}$, γemission probabilities, F.P. yields	Fission products &Fissile isotopes		
	- Neutron Coincidence Techniques	Correlation of emitted radiation spontaneous fission	Pu isotopes		
	- Passive γ assay	Decay data (E_γ, I_γ ...)	U&Pu isotopes, Am^{241}	required data considered to be adequate	"
	- Burn-up calculations	Reaction and decay data	Fissile & Fertile isotopes & F.P.		
	Gamma-Spectrometry (of fission products in fuel elements)	Fission yields, $T_{1/2}$, neutron capture and fission σ, E_γ and I_γ	Fissile materials and F.P.		

Fields and Subfields of Applications	Methods and Techniques	Nuclear Data needed	Examples of most important isotopes	Comments	References
Non-destructive nuclear assay	Fast neutron irradiation	Prompt & delayed fission neutron yields	Fissile materials		Paris 73,1,217 (Thorpe)
	Gamma-ray spectroscopy	Decay data (E_γ, I_γ, ...)	Fissile materials		
	Coincidence of fission events with fission neutrons and gamma rays	Spontaneous fission yields neutron & gamma correlation	Fissile materials	use of Am-Li neutron source	"
	Basic signature	neutron capture gamma rays			
		delayed neutron and gamma spectra γ- and x-ray fluorescence natural radioactivity	Fissile materials		"
See also Safeguards Nuclear Data Request List (INDC(NDS)-50/U+S)					
Life Sciences					
Medical dosimetry	Radiation dose estimate due to internal bremsstrahlung caused by β-decay of radioisotopes.	fluorescence yields, relative X-ray and Auger electron yields – Internal conversion coefficients, electron binding energies, etc. .. atomic transitions	up to 400 nuclides	nuclear structure and decay data used to establish ICRP standards	Paris 73,2,529 (Dillman) (see also references to this article)
Clinical diagnostics	Radioisotpe production	Exact nuclear decay schemes	Heavy Hg^{197}, Tl^{204}, Cu^{67}		
	Radiography	" " " "	Mo^{99}, Te^{99m}, Ba^{137m}		
	Activation analysis	" " " "	Lights: O^{15}, C^{11}, N^{13}	use of medical cyclotron for short term isotope production by activation	
Medical Dosimetry	Calculation of internal dose	Internal Conversion Electron capture, x-ray, Auger electron yields – (decay schemes)	Hg^{197}, I^{125}		Paris 73,1,287 (Kellersohn)
		Neutron capture gamma-rays	H, N, Ca, P, Na, Cl, Mg, I (I^{130m})		
Radiotherapy (Radiological protection)	Irradiation	Neutron, Camma-ray & X-ray, ions interaction with tissue Reaction data Energy loss of electrons (stopping powers) Penetration of particles ...	H, C, O, N (Bio-tissue)	Effect of radiation on bio-tissue	Paris 73,1,313 (Dennis)
Production of thermo-electric generators	Radioisotope production (for pacemakers)	(α,n), (γ,n) and (n,2n) reactions (α,α' γ), (α,pγ) Decay scheme of source isotopes	F, O, Al, Ca Pu^{238}, Pu^{236}, Np^{237}	Purity of Pu^{238} product is important factor	Paris 73,1,329 (Bc ger)
Medical Radiation Physics	Activation Analysis	Activation reaction data Decay scheme data	(see table in article on page 336)		Paris 73,1,335 (Spyrou)
Pharmacology	Standardization of radioisotope (production) and quality control)	Decay schemes ($T_{1/2}$, E_γ, I_γ)	Cr^{51}, Co^{57}, Co^{58}, I^{125}, I^{131}, P^{32}, Au^{198}, Hg^{197}, Sc^{75}	Establishment of required standards	Paris 73,1,351 (Cohen)
Radionuclide application in Medicine & Biology	Radioisotope preparation	Isotope production cross-sections Decay schemes, half-lives ...	(see tables in article)	High accuracy required (few %) (Table of medical cyclotrons in article)	Paris 73,1,359 (Persson)
	Side effects → radiolysis of target materials				

Fields and Subfields of Applications	Methods and Techniques	Nuclear Data needed	Examples of most important isotopes	Comments	References
Chemistry					
Nuclear Chemistry	Radiochemical Analysis Radioactive tracing Isotope Labelling	Decay schemes	various		Paris 73,1,377 (Gorski)
Geochemistry (Geochronology)	Radiodating	Decay schemes	Pb^{207}, Pb^{206}, Pb^{208}, U^{235}, U^{238}, Th^{232}, Ar^{40}, K^{40}, Sr^{87}, Rb^{87}, C^{14}		"
Hot-Atom Chemistry	Radiochemical Analysis	Alpha-decay, Reaction data Neutron capture, Electron capture, Isomeric transitions, β-decay β^+ decay - Charge distribution (e)	various		Paris 73,1,383 (Aten)
Hydrology					
Atmospheric water	Radiochemical sampling	$T_{1/2}$, decay schemes	H^2, O^{18}, H^3, Ra^{226}		IAEA, TR 91 (1968)
Surface water	Isotope tracing/labelling	$T_{1/2}$, decay schemes	Br^{82}, I^{131}, Au^{198}, H^3 Cr^{51}, Ir^{192}, Sc^{46}, Ta^{182}, Zn^{65}, Cd^{109} and Am^{241}, Co^{60} →	calibration standards	"
	Autoradiography	$T_{1/2}$, decay scheme	P^{32}, Sc^{46}		"
	Gamma-ray scattering (sediment density determination)	γ-ray scattering cross section	Cs^{137}, Co^{60}		"
	Radiodating (of glacier ice)	$T_{1/2}$, decay schemes (α,β,γ)	O^{18}, H^2, Pb^{210}, H^3 Si^{32}, C^{14}, C^{12}		"
Subsurface water	Gamma-ray transmission (Soil moisture and soil density measurement)	γ-ray interaction coefficients (Mass/Energy Absorption and scattering)	Co^{60}, Cs^{137} (Earth crust isotopes)		" (p.95)
	Isotope tracing & labelling	H, O^{18}, H^3, C^{14} (water constituants) Co^{60}, Br^{82}, I^{131}, Au^{198}, Cr^{51}, (as molecular compounds)			"
	Gamma logging Gamma-gamma logging neutron-neutron logging neutron-gamma logging	$T_{1/2}$, decay schemes gamma-ray interaction coefficients neutron reactions (scattering absorption, capture, etc.)	Earth and rock isotopic component		" (p.156)

ATTACHMENT 1

Specialists' Meeting on Nuclear Structure and Decay Data for Applications

29 April - 3 May 1974

Adopted Agenda

1. Formal opening and statement of objectives
2. Appointment of Chairman
3. Chairman's comments
4. Announcements
5. Introduction of Agenda changes
   - adoption of Agenda.
6. Present and future data applications.
7. Short Statements by participants concerning their home programs.
8. Discussion of recommendations on international collaboration in compilation and evaluation of nuclear structure and decay data used in science and technology.
9. Discussion of recommendations on mechanisms for dissemination of compiled and evaluated data.
10. Working parties draft recommendations for items 8 and 9.
11. Discussion of draft recommendations and adoption of agreed recommendations for item 8.
12. Discussion of draft recommendations and adoption of agreed recommendations for item 9.
13. Other items
    - Authors guide.
14. Need for future meetings.
15. Closing of meeting.

ATTACHMENT 2

List of Participants

Specialists' Meeting on Nuclear Data for Applications

Vienna, 29 April - 3 May 1974

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ATTACHMENT 3

List of Papers Presented at the Meeting

The reports listed below were submitted to the meeting by the participants. Excluding those documents published elsewhere or retracted, those marked by an asterisk (*) are published in INDC(NDS)-61 together with statements made by the participants about the status of their own non-neutron nuclear data programmes. In addition, INDC(NDS)-61 also contains those reports presented at the Consultants' Meeting on Charged Particle and Photonuclear Reaction Data (Vienna, 24 - 26 April, 1974). The Summary report of that meeting is published in INDC(NDS)-59.

List of Papers

* 1. Computerized Libraries of Nuclear Data, S. Pearlstein (March 1, 1974).

* 2. Computerized Libraries of Nuclear Data for Applications, S. Pearlstein (April 1, 1974).

* 3. Nuclear Data Section Short Guide to EXFOR.

* 4. Nuclear Structure Data File - Preliminary Specifications, Nuclear Data Project (March 29, 1974).

* 5. Memo to Nuclear Data Project Compilers Subject: Data Bank Standards. W.B. Ewbank (March 20, 1974).

* 6. Nuclear Data Project, D. Horen (29 April 1974).

* 7. Non-Neutron Nuclear Data: A Proposal for International Cooperation, A. Lorenz, (April 29, 1974).

8. Nuclear Data in Science and Technology: Structure and Scope A. Lorenz, (April 29, 1974) (to be published separately).

* 9. Information Center for Applied Users C.A. Bartholomew (26 April 1974).

10. Draft Recommendations IAEA Consultants Meeting on Charged Particle and Photonuclear Reaction Data (24 - 26 April 1974)(see final version published in INDC(NDS)-59).

* 11. State of Work on Non-neutron Nuclear Data in the USSR L.L. Sokolovskij, Yu.I. Fenin, F.E. Chukreev, Moscow, 1974.

12. Conclusions and Recommendations of the first Meeting of the International Working Group on Nuclear Structure and Reaction Data L. Hjärne (13 - 17 March 1972) (see original published report INDC(NDS)-46/U+W).

* 13. 6th INDC Meeting, Recommendations (1973).

* 14. 6th INDC Meeting, Requirements and applications of border-line nuclear and atomic data,
D. Berenyi (Oct. 1973).

* 15. Notes on a Computerized Decay-Data File
C.M. Lederer & A. Shihab-Eldin (April 22, 1974).

* 16. NUSPEC (Nuclear Spectroscopy Interactive Program Package)
Table of Isotopes Project, Lawrence Berkeley Lab.,
C.M. Lederer, A. Shihab-Eldin.

17. Survey of Nuclear Data Use,
C.M. Lederer (29 April 1974) (Retracted).

* 18. Draft Statement by D. Horen, (30 April 1974).

19. Samples of Computer-Produced Plots for the "Table of Isotopes".
A. Shihab-Eldin (30 April 1974). (Retracted).

20. Draft Recommendations + Revision 1 (Retracted).

* 21. Status of Author's Guide,
G. A. Bartholomew (26 April 1974).