International Atomic Energy Agency

INDC(NDS)- 30

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

REPORT OF A CONSULTANTS MEETING

ON NON-NEUTRON NUCLEAR DATA

Vienna, 23-25 November 1970

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Vienna, February 1971

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

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Participants

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Spernol, A.	Euratom	Observer
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ABSTRACT

The Consultants Meeting on Non-Neutron Nuclear Data in Vienna, 23 - 25 November, reviewed the status of nuclear structure and related data, as regards compilation, evaluation and dissemination of the information. The status reports presented at the meeting demonstrated a general severe shortage in manpower, funding and coordination of the existing dispersed activities resulting in an actual delay of data coverage of the order of 5 years. The conclusions of the group include a distinct recommendation to the IAEA to take an initiative towards better international collaboration in the field. The formation of an international working group is suggested to be the best approach.

1. INTRODUCTION

The meeting was opened by the Deputy Director General, Dr. Finkelstein who emphasized that this is a small group of consultants not representing all sub-disciplines in nuclear data. He also recognized that the problems which this group is facing are of a magnitude which could not be fully solved there and then.

Dr. Finkelstein further wanted it to be understood that support from the IAEA must be very limited during the next couple of years. Any recommendations that would involve financial obligations on the part of the agency would require extensive justifications. Furthermore, any action that the group may suggest must not interfere too deeply with the present program of the Nuclear Data Section, whose workload is already substantial.

2. SUMMARY OF BACKGROUND

In 1968 Dr. Hollander suggested in a proposal to the IAEA that the Agency, through meetings or otherwise, sponsor international collaboration in the field of nuclear level and radio-isotope data. In 1969 Dr. Y. Le Gallic (France) pointed out to the Agency that only an initiative from an international organization like the IAEA could resolve the present pressing problems in the collaboration on evaluation of the data.

The lack of availability of information on nuclei has become a critical problem, aggravated by the rapid increase of the amount of new data and the urgent need for such data by physicists involved in nuclear research as well as by researchers in fields (such as medicine, agriculture, dosimetry) where nuclear data are applied. Recently also the need for nuclear data in connection with safeguards technical development has been expressed to the Agency and similar explicit needs are expected to be expressed in the near future for application in the development of nuclear fusion reactors. In order to improve access to recent information, coordination and collaboration among existing nuclear data compilation groups outside the neutron field and the users of such data are urgently needed. From the discussions of the consultants group it was clear that one of the most pressing needs in the field of non-neutron nuclear data concerns more up-to-date compilations and evaluations. The compilers had

recognized this need long ago, and they have pressed for increased financial support of their activities. However, such efforts have met with only partial success. Thus, the situation today is that more than half of the mass numbers have not been covered by thorough compilation and evaluation work since 1965, and that over one fourth are already 10 years out of date.

While additional financial support is awaited, several steps can be taken to improve the situation. Detailed programs for cooperative efforts can be discussed and encouraged. The exchange of evaluated data which already takes place informally, could be extended and made more systematic. The utilisation of computers in compilation and evaluation work should be developed much further than at present. Particularly, agreements on formats and file contents, as well as input and output information, are prerequisites for any systematic collaboration.

On 22 May this year a group from EURATOM countries met in Geel to discuss evaluation of non-neutron nuclear data. That group agreed that the present situation is very unsatisfactory and that only a truly international effort would be instrumental towards an improvement. The planned activities of the IAEA were regarded as too slow, and the EURATOM group decided therefore to begin a limited action in the meantime. The group listed about 100 nuclides (out of the about 1700 known isotopes) which are important for radioactivity standards and applications. For these nuclides decay schemes and related data will be evaluated in a cooperative program within a relatively short time. In order to establish well-defined rules for evaluation the four laboratories involved agreed to make an initial study of the decay schemes of ^{58}Co and ^{65}Zn. The EURATOM group has met a second time and discussed very preliminary experiences from the exercise. The Consultants Group agreed that the EURATOM study has great value and recommended (see appendix II) that IAEA should try to have the results published in the Agency's Atomic Energy Review when the study has been completed.

The Consultants Group discussed a proposal which was made by I.P. Selinov (USSR) to the CODATA Conference in Sept. 1970. Selinov had made some observations similar to those of Hollander. He had specifically pointed to a number of serious problems in the compilations available at present, such as the following ones:

a) Terminology symbols and notations are different in various compilations, and a unification is desirable.

b) Because of the rapid growth of nuclear data, compilations have a tendency to become obsolete more rapidly than in the past.

c) As regards misprints and omissions the present situation is alarming. Quality must necessarily suffer in a compromise with rapid publication, and therefore a critical discussion of deficiencies of available reference books is, according to Selinov, very urgent.

d) Disagreements between compilers are not brought to the attention of the users, who are consequently facing contradictory information without appropriate comments from the compilers. Even inconsistencies within compilations tend to confuse the users.

The Consultants Group felt that Selinov's contribution to the discussion was valuable and it was regretted that neither he nor any other Soviet participant was present, which severely impeded a full discussion of the subject for the meeting.

Some problems related to data from nuclear physics experiments in the USSR were pointed out by the consultants. In a number of fields the high scientific value of Soviet work gives a special emphasis to the need for international collaboration. Some examples were given during the discussion:

- Neutron deficient isotopes in the deformed region;
- Contributions on precision α-spectroscopy;
- Heavy element properties;
- Detection of trans-Fermium isotopes and investigation of their properties;
- Fission isomers (Flerov, Dubna);
- Mass-doublet data (mass spect.) (Demirkhanov);
- Data in the "Groshev Atlas".

In publications there are often information gaps, which can be filled only by contacting the author directly. It is urgent that channels of communication be opened, and particularly Soviet collaboration on compilation and evaluation of nuclear structure and related data was generally felt to be highly desirable.

On the part of the IAEA, the mission-oriented need of reactor development, which in the past has been the primary incentive for its nuclear data activities, has recently been

complemented by mission-oriented needs in other fields. The data of primary concern in safeguards and nuclear fusion work are reaction data such as charged-particle-induced reaction cross sections and photonuclear data, which are also used in the evaluation of nuclear structure data.

The consultants' group was unanimous in stressing that the present situation is bad indeed, and that cooperation between groups as well as additional financial support are prerequisites for an improvement. The urgency has been illuminated by a recent proposal in the U.S. by H. Feshbach, who has suggested a "crash" program, involving 25 post-doctoral physicists to catch up and bridge the worst gaps in available nuclear structure data compilations.

3. PROPOSED MECHANISM FOR INTERNATIONAL COLLABORATION AND COORDINATION OF THE COMPILATION, EVALUATION, AND DISSEMINATION OF NUCLEAR STRUCTURE AND REACTION DATA

During the consultants group's discussion it became clear that a number of subjects require further extensive discussion in a larger group which could meet repeatedly and which could enter into greater detail. It was agreed that such a group should have, if possible, representation from the various major compilation activities, including those in the USSR. In the following paragraphs will be outlined the present status and the immediate needs for improvements and the particular subjects which require discussions in a larger group of compilers and evaluators.

It was therefore recommended (see appendix I) that the Agency tries to find ways and means to form an International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data.

It was recommended that the working group might include the following scientists, who have a considerable interest and involvement in the subject.

B.S. Dzelepov or L.K. Peker	USSR
I.P. Selinov	USSR
F. Ajzenberg-Selove or T.Lauritsen	USA
J.M. Hollander or C.M. Lederer	USA
D. Horen	USA
F.K. McGowan	USA
D. Goldman or E.G. Fuller	USA

A. H. Wapstra	Netherlands
A. Spernol or W. Bambinek	EURATOM
B. Grinberg or Y. Le Gallic	France
M.D. Goldberg	USA
S. Pancholi	India
L.V. Groshev or A.M. Demidov	USSR
K. Way	USA
P. Endt or C. van der Leun	Netherlands
Mr. Weiss	Germany (Fed. Rep.)
G.A. Bartholomew	Canada
Dj.Bek-Uzarov	Romania

4. DATA USERS

The consultants felt that the responsibility of keeping contact with users should remain, like in the past, with the individual centres. In addition to the producers of data - nuclear physicists dealing with nuclear structure and reaction data in theory and experiment - there are a number of user categories in various branches of applied science and technology:

- Reactor development and design
- Reactor and space shielding
- Nuclear materials safeguards
- Nuclear fusion
- Biomedicine
- Industrial applications
- Chemistry
- Agriculture
- Miscellaneous physics fields (astrophysics, cosmology, solid state physics etc.)
- Miscellaneous other fields (environmental research, archeology etc.)

The above classification is of course rather superficial and one could instead mention multipurpose applications which are widely used, such as activation analysis, dosimetry, tracer techniques, radioisotope production. Safeguards and nuclear fusion are right now of particular interest to the Agency and its program. However, in various fields where nuclear data are applied, such as life sciences, industry and agriculture the Agency carries a great "information responsibility" as these fields basically pertain to the Agency's programs for assistance to developing countries. In paragraph 5.3, where the scope will be discussed, the data is grouped in the main categories observables and properties of nuclear levels. Most data

needed in the various applied fields are found among the observables. One must not forget, however, that the structure data and the fundamental properties of nuclides are of great importance to nuclear structure physicists, who are also the suppliers of new and improved reaction and radiation data.

The consultants group took note of the request lists for nuclear data measurements, such as those which have been established in the neutron data field, and considered as an appropriate subject for discussion by the international working group the utility of such request lists also in the field of nuclear structure and related data.

5. INFORMATION INPUT, PRESENT STATUS, NEEDS, ETC.

5.1. Literature scanning and indexing

The present scanning of primary literature in the field of nuclear physics is mainly made by each group independently, the only exception being a recent agreement between the Berkeley group and the nuclear data group in Oak Ridge. Lists of references and indexes are published by the nuclear data group as separate issues of the journal "Nuclear Data" part B. Cumulative indexes are published occasionally. Indexes and reference lists with limited keyword indexing are also available, to a very limited extent, on magnetic tape. In this connexion the consultants' group found that no one of the data centres has been able to rely on documentation services like Nuclear Science Abstracts, for adequate coverage of the literature.

It was therefore recommended (see appendix II) that steps be taken by the IAEA to initiate discussions between documentalists and data specialists, with the objective of increasing the usefulness of documentation services to compilers in specialized fields.

Input information can be found in journal papers, conference proceedings, preprints, progress reports, laboratory reports and private communications. Generally the information content of these sources does not meet the requirements of a reasonable basis - in terms of experimental details - for evaluation of data. The establishment of a set of minimum standards of information content and presentation, in the form of a recommendation to authors, journal editors and referees, should therefore be an important task of the international working group. The media for communication of this information should also be discussed. A proposed

mechanism for doing this within the framework of conventional journals has been made by the Oak Ridge group. They have also already taken steps to enlist the journal editors to cooperate in this task.

The consultants' group expressed the hope that similar efforts could be made in the USSR, where the coverage of literature, as well as of other information from authors, presents a substantial problem to compilers. International cooperation within the framework of a working group would greatly contribute to better exchange of information. In fact, Soviet participation in such a group would be a most important stimulus towards a world-wide program for collaboration.

5.2. Input numerical data

Compilers of neutron data have concluded that, in their field, numerical data are best acquired directly from the researcher. In the other fields of nuclear data there will be difficulties in establishing direct contact between data producers and data centres; in this respect there is an obvious difference from the neutron data field in that the number of producers of nuclear data is larger (of the order of several thousand). The delineation of responsibilities, in this respect, between the information centres might be discussed by the international working group.

5.3. Scope of input data

The scope of the data involved at the input end of this process can be described as follows:

1. Observables

α spectra
β spectra
γ spectra
neutron spectra
proton spectra
time correlations (half-lives)
space correlations (angular distributions and correlations)
cross sections for reactions (including fission cross sections and yields)

2. Properties of nuclear levels

level energies (including masses)
α-, β-, γ-, n-, p-branching ratios
level half-lives
spins, parities, shell model and Nilsson assignments
multipolarities
magnetic and electric moments
nuclear radii and shapes (deformations)

5.4. Extraction of data and other information from the literature

Currently there exists no general up-to-date experimental data file in a computer medium. In the consultants group there were differences of view regarding the feasibility of establishing complete data files with present manpower and budgets. Because of the limited resources available at present, a certain amount of evaluation is being performed already at the stage of extraction with unfortunate incompleteness as a consequence. This is probably the area of greatest need and, at the same time, of greatest possibilities for collaboration in the nuclear data field. It will be one of the main tasks of the international working group to prepare a proposal for implementation of primary data files. Clearly, the large volume of data information will require that data files be created at different centres. Such a scheme would require agreements on compatibility of the files in order to facilitate full exchange of their respective contents.

6. EVALUATION

Because of the awkward situation as regards input information, and because of the very limited manpower resources available, the current status of up-to-date evaluation is rather poor. For example: for those isotopes within the scope of the nuclear data group at Oak Ridge, the situation is as follows:

Date of most recent evaluation	No. of isotopes compiled and evaluated	Mass numbers compiled and evaluated
1970	14 (+ 14 in preparation)*	45-58, (229-242)
1969	19	243-261
1968	8	59-61, 65-69
1967	10	62-64, 142-148
1966	38	70-83, 182-189, 213-228
1965	10	172 - 181
1964	16	150;152;154;156;158; 160;162-171
1963	15	151;153;155;157;159;161; 190-192;199;200;209-212
1962	11	84;108;149;196-198; 201-205
1961	27	99-105;127-139;141; 193-195;206-208
1960	34	85-98;106;107;109-126
1959	1	140
Total	203	

*) Note added in proof: For 1970 the figures can be revised to the status in mid-December (after the meeting) to : 25 (+22 in preparation) which brings the total up to 236 isotopes.

The current status as regards the light isotopes can be summarized as follows:

Mass or element range	Date of last evaluation	Reference
A=4	1968	E. Meyerhof and T.A.Tombrello, Nucl.Phys. A 109, 1
A=5 to 10	1966	T. Lauritsen and F.Ajzenberg-Selove, Nucl. Phys.78, 1
A=11 and 12	1968	F.Ajzenberg-Selove and T. Lauritsen, Nucl.Phys.A114, 1 (1968)
A=13 to 21	1959-1968	F.Ajzenberg-Selove and T.Lauritsen, Nucl.Phys.11, 1 (1959); Landolt-Börnstein,New Series, Group I, 1-94 (1961); Nucl. Data Sheets 61-5, 6 (1962); F.Ajzenberg-Selove,Nucl. Phys.A152, 1 (1970)
Z=11 to 12	1967	P.M. Endt and C.van der Leun, Nucl.Phys. A105, 1

It is difficult to design a procedure to catch up with the massive backlog of evaluation work, and several possibilities are open. The strategy to be adopted will of course depend upon the extent of financial support devoted to the task. The Nuclear Data Project of Oak Ridge proposes to introduce a scheme of "quickies", which includes an element of evaluation by selection. The "quickie" compilation would be based on computer programs which can prepare the output in copy-ready form for publication purposes from a data file. For this scheme the cooperation of physicists in basic research will be required; they would send in their results in a format which can readily be introduced into the files. They would also be welcomed to assist in the evaluation process if they so desire. The "quickie" compilation is basically a set of ladder diagrams and tables of energy levels, spins, parities and angular momentum transfers for each nucleus. The Oak Ridge group has finished the first edition for the range A = 91 - 117. With the help of frequent "quickie" editions they hope to catch up with the current development and to eliminate what they call "the pathetic outdatedness of the compilation in many regions

of the periodic table". It was stressed by the Nuclear Data Project that a certain level of cooperation is required in order that the data file can be maintained on a current basis.

It is the view of the Nuclear Data Project that over long periods of time the "quickie" type compilation and the careful evaluation in depth could take similar form, but the rough compilation can never replace the thorough compilation. Unfortunately, the present trend is that the resources available to evaluation in this field do not allow for sufficient time for good evaluation work and there is a danger that in the resulting compromise urgently needed evaluation in depth might be reduced to a very small activity.

7. DISSEMINATION

There is no doubt that the dissemination media of various kinds supplement each other. The complete evaluations of each isotope as presented by the nuclear data group in the journal Nuclear Data, Part B, find great use in the scientific and technical community. There is also no doubt that the concise handbook-type compilations like the "Table of Isotopes" of the Berkeley group are extremely useful. The international working group could try to find an optimum use of available dissemination media. Included in such a study should also be computer media such as magnetic tapes or telecommunication. For example: some effort is now being invested in the development of programs for displaying nuclear level schemes on a cathode-ray-screen display device, which could be very useful to the rapidly growing number of users with appropriate equipment. The dissemination of information through other handbooks and various publications such as the nuclide chart also enter into the picture.

APPENDIX I

PRINCIPAL RECOMMENDATION (Recommendation I)

It is recommended to the Director General of the IAEA that an International Working Group on the Compilation, Evaluation and Dissemination of Nuclear Structure and Reaction Data be formed. The general terms of reference of this group are suggested to be:

- To establish guidelines for the compilation, evaluation and dissemination of nuclear structure and reaction data.

- To review comprehensively the status of, and needs for, nuclear structure and reaction data and to establish guidelines for international coordination of compilation and evaluation work and to investigate means for providing dissemination of data that will adequately serve the users.

Specific long-term objectives of the Working Group were suggested as follows:

A. Compilation

- To review the current status of, and needs for, compilation activities.

- To prepare recommendations for the scope and depth of data to be compiled (including errors, experiment detail, etc.).

- To try to subdivide the compilation tasks among centres according to physical or geographical criteria.

- To seek to find optimum ways of transferring information (feasibility of making compatible data files, formats and index terms).

- To prepare recommendations to authors, editors and journal referees, regarding appropriate documentation of published or otherwise disseminated data.

- To investigate the question of the level of manpower and funding necessary for comprehensive implementation of the compilation tasks.

B. Evaluation

- To review the current status of, and needs for, evaluations.
- To discuss experience in and guidelines for evaluation.
- To investigate the feasibility of compatible computer formats and files for evaluated data.
- To study the feasibility of making available to users computer programs for data handling.

C. Dissemination

- To investigate the relative usefulness of different information media such as monographs, primary journals, review journals, laboratory reports, and magnetic tapes and other computer media.

APPENDIX II

OTHER RECOMMENDATIONS

Recommendation II

In view of the very valuable contributions of the USSR in the field of nuclear structure and reaction data it is recommended that Soviet participation in the Working Group is encouraged.

Recommendation III

It is recommended that the results of the EURATOM study (mentioned in section 2 of this report) be published in the IAEA Atomic Energy Review.

Recommendation IV

The consultants group has found that, in their present form and quality the information services from documentation systems linked to INIS, such as Nuclear Science Abstracts, are not very useful to the data centres. In view of the potential value of a collaboration, it is therefore urgently recommended that the IAEA, within the framework of INIS, venture to find appropriate ways and means for the documentation systems to establish an appropriate interface with the activities of data centres in nuclear physics.