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# INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

IAEA Advisory Group Meeting
on
Nuclear Structure and Decay Data

IAEA, Vienna
21-25 April 1980

SUMMARY REPORT

Edited by A. Lorenz
Nuclear Data Section
International Atomic Energy Agency

October 1980

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

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## SUMMARY REPORT

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## Abstract

The IAEA Nuclear Data Section convened the fourth meeting of the international nuclear structure and decay data network at IAEA Headquarters in Vienna, Austria, from 21-25 April 1980. The meeting was attended by 23 Scientists from 11 Member States and 2 international organizations, concerned with the compilation, evaluation, and dissemination of nuclear structure and decay data.

# Table of Content

## List of Appendices

# DEFINITION OF TERMS

Nuclear Structure Data: numerical values of nuclear level structure and decay parameters and associated atomic parameters of pertinence to nuclear techniques and methods.

Tabulation: systematic collection and transcription of numerical information without critical selection or manipulation.

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

Evaluation: critical appraisal of all available information compiled on a given subject and derivation of consistent best or preferred values with their uncertainties.

Mass-chain (vertical): pertaining to properties of nuclides with a given mass number.

Selected (horizontal): pertaining to a particular nuclear property or properties for a range of nuclides.

## List of Abbreviation

| | |
|---|---|
| CAJaD | Centre for Data on the Structure of the Atomic Nucleus and Nuclear Reactions of the USSR State Committee on the Utilization of Atomic Energy, located at the Kurchatov Institute in Moscow. |
| CBNM | Central Bureau for Nuclear Measurements, located at Geel, Belgium. |
| CODEN | International code for the abbreviation of periodical titles used by ASTM, INIS and Chemical Abstracts. |
| CPND | Charged Particle Nuclear Data. |
| EBCDIC | Extended binary-coded decimal interchange code. |
| ENSDF | Computer-based Evaluated Nuclear Structure Data File developed by US/NDP. |
| EXFOR | Exchange Format, internationally used format for the exchange of experimental nuclear reaction data. |
| FIZ | Fachinformationszentrum Energie, Physik, Mathematik GmbH, Eggenstein-Leopoldshafen, FRG. |
| IAEA/NDS | Nuclear Data Section of the International Atomic Energy Agency. |
| INDC | International Nuclear Data Committee. |
| INIS | International Nuclear Information System, operated by the IAEA, to replace Nuclear Science Abstracts. |
| KACHAPAG | Karlsruhe Charged Particle Group. |
| LIYaF | Leningrad Institut Yadernoy Fiziki: Data Centre of the Leningrad Nuclear Physics Institute of the USSR Academy of Sciences. |
| NSR | Nuclear Structure Reference (file). |
| NDS | Nuclear Data Sheets. |
| NSDD | NSD data = Nuclear Structure and Decay Data. |
| US/NNDC | US National Nuclear Data Centre, located at the Brookhaven National Laboratory. |
| US/NDP | Nuclear Data Project located at the Oak Ridge National Laboratory. |

## Foreword

The international nuclear structure and decay data (NSDD) network, consisting of numerous evaluation groups and data service centres, aims at a complete and continuous nuclear structure data evaluation of all isobaric mass-chains on a four-year cycle, the continuous publication of these evaluations and their dissemination to the scientific community. The evaluated mass-chain data resulting from this concerted international effort are published in Nuclear Physics A and the Nuclear Data Sheets, and comprise the currently recommended "best values" of all nuclear structure and decay data. The international NSDD network has evolved from the long-standing cooperation between the US effort, initiated by the Oak Ridge Nuclear Data Group and presently coordinated by the National Nuclear Data Centre at the Brookhaven National Laboratory, and the effort at the Rijksuniversiteit at Utrecht in the Netherlands.

Periodic meetings of this network have the objectives to maintain the coordination of all centres and groups participating in the compilation, evaluation and dissemination of NSDD, to maintain and improve the standards and rules governing NSDD evaluation, and to review the development and common use of the computerized systems and data bases maintained specifically for this activity.

# I. Summary of the Meeting

## A. Introduction

The fourth Advisory Group Meeting on Nuclear Structure and Decay Data (NSDD) was convened by the IAEA Nuclear Data Section at IAEA Headquarters in Vienna, Austria, from 21-25 April 1980. The meeting was attended by 23 Scientists from eleven Member States and two international organizations, representing centres and groups concerned with the compilation, evaluation and dissemination of nuclear structure and decay (NSD) data. The list of participants is given in Appendix 1.

The meeting was conducted in two separate sessions; the morning sessions, devoted to the coordination of the NSDD network or centres and groups were chaired by Dr. J.J. Schmidt, the afternoon sessions, devoted to physics questions related to the evaluation of NSDD, were chaired by Dr. C. van der Leun. The Adopted Agenda are given in Appendix 2, and the list of papers submitted to the meeting by the participants is given in Appendix 3.

## B. Objectives

The international NSDD Network, consisting presently of 16 evaluation groups in 11 Member States and 2 international data service centres, aims at a complete and continuous nuclear structure data evaluation of all isobaric mass-chains on a four year cycle, the continuous publication of these evaluated data, and their dissemination to the scientific community. This international cooperative effort is coordinated by the Nuclear Data Section of the IAEA.

The periodic meetings of the international NSDD network, have the objective to maintain the coordination of all centres and groups participating in the compilation, evaluation and dissemination of NSDD, to maintain and improve the standards and rules governing NSDD evaluation, and to review the development and common use of the computerized systems and data bases maintained specifically for this activity.

All members of the international NSDD network are referred to in the text of this report by their identification code agreed at the May 1976 NSDD meeting. A current list of these centres, together with their codes and addresses, is given in Appendix 31.

## C. Conclusions and Recommendations

While a more detailed account of the meeting proceedings is given in Part II of this report, the main achievements, summarized as conclusions and recommendations, are listed below. The Actions which resulted from this meeting are listed in Appendix 4.

## Summary of Conclusions and Recommendations

- The meeting reviewed the status of the international NSDD Network, the progress of mass-chain evaluations, and the current mass-chain evaluation responsibilities. It concluded that even though a mass-chain evaluation cycle of four years had not yet been achieved, the overall progress was satisfactory.

- The meeting re-examined the NSDD mass-chain evaluation and review procedures, and accepted the "Normal Procedures for Mass-Chain Evaluation" as adopted at the November 1977 NSDD meeting.

- The meeting reviewed on-going and planned publications of NSDD, and recommended that new information contained in horizontal compilations be fed into the ENSDF file.

- The meeting reviewed the status of the Nuclear Structure Reference File, discussed its distribution and suggested ways to improve the quality of this file.

- The meeting reviewed the status of the Evaluated Nuclear Structure Data File (ENSDF) and its associated system, and adopted guidelines for referring to ENSDF as a reference in the open literature.

- The meeting discussed the physics of NSDD evaluation, came to a number of agreements with regard to terminology, and made substantial physics recommendations aimed at improving the standards and rules governing NSDD evaluation.

## D. Next Meeting of the NSDD Network

### a. Time and Place

At Utrecht, The Netherlands, during the week of either 3 - 7 May or 10 - 14 May 1982.

### b. Suggested Agenda Items for Next Meeting

Coordination

- Priority in the choice of mass-chains to be evaluated
- Review of "Evaluation Review Procedures"
- Changes in "Nuclear Data Sheets" format
- Changes in the ENSDF System
- ENSDF "Working File"
- NSDD Service centres and geographical service areas

Physics

- Physics content of Wall Chart of Nuclides
- Common conventions and notations, abbreviations
- IUPAP list of terminology and definition
- Additions, changes and deletions of $J^{\pi}$ assignment rules
- Arguments on isospin assignment

## II. Summary and Highlights of the Discussions

### A. NSDD Network Coordination

#### A. 1. Review of Actions and Recommendations from last meeting

Most November 1977 Meeting Actions were discussed in the course of this meeting under the pertinent agenda item. For the full text of the 1977 Actions, the reader is referred to Appendix 4 of the 1977 NSDD Meeting Summary Report (INDC(NDS)-92/LN). Standing actions from the 1977 meeting were adopted as continuing actions and are included in this meeting's List of Actions, Appendix 4.

Recommendations from the 1977 meeting were noted, and relegated for discussion and review under the pertinent agenda item of this meeting.

#### A. 2. Status Reports from NSDD Network Members and Observers

Status reports made by the members of the NSDD network are reproduced in this report as Appendices. Summary of the order of these presentations and the reference to the relevant Appendix is given below.

1. Status Report. P.M. Endt and C. van der Leun. Appendix 5. (Recorded as AG-258/27).
2. Activities Relating to the Evaluation of Nuclear Structure and Decay Data carried out by the Centre for Atomic and Nuclear Data. G.M. Zhuravleva and F.E. Chukreev. Appendix 6. (Recorded as AG-258/26).
3. Status Report from FIZ. H. Behrens and T.W. Tepel. Appendix 7. (Recorded as AG-258/22).
4. Status Report - Nuclear Structure Data Evaluation in Sweden. B. Erlandsson. Appendix 8. (Recorded as AG-258/7).
5. Statement on CBNM Activity in Evaluation and Compilation. W. Bambynek. Appendix 9. (Recorded as AG-258/9).
6. NEA Data Bank Customer Service from the Evaluated Nuclear Structure Data File (ENSDF). N. Tubbs. Appendix 10. (Recorded as AG-258/32).
7. Status Report of the Franco-Belgian Group. J. Blachot. Appendix 11. (Recorded as AG-258/29).
8. Status Report. P.J. Twin. Appendix 12. (Recorded as AG-258/33).
9. US Position on International Cooperation in the Area of Nuclear Structure Data. S. Pearlstein. Appendix 13. (Recorded as AG-258/13).
10. Status Report on Nuclear Structure and Decay Data Evaluation Project in Kuwait. B. Singh. Appendix 14. (Recorded as AG-258/31).
11. Status Report on Japanese Activities in Nuclear Strucutre and Decay Data. T. Tamura. Appendix 15. (Recorded as AG-258/3).

In the course of discussion of the various progress reports, concern was expressed by the network that nuclear data evaluation and specifically nuclear structure data evaluation, is not given due recognition as a scientific endeavor by the administrative organs responsible for its support, particularly in Sweden. The meeting resolved to publicize results of questionnaire surveys on the use and usefullness of published evaluated NSDD, and formulate supporting evidence of the international effort in NSDD evaluation.

Action 2 and Action 3

A.3. Report on the Status of the NSDD Network

In view of the impending transfer of responsibilities within the U.S. NSDD network, most of this agenda item was devoted to this topic. Most of paper AG-258/13 presented by US/NNDC, related to this transfer of responsibilities, is reproduced below under appropriate points of the Agenda.

Transfer of Data Base and Publication Functions to US/NNDC

At the request of the United States Department of Energy and the Oak Ridge National Laboratory, the National Nuclear Data Centre (US/NNDC) will assume responsibility of the nuclear structure and decay data base and related publication activities currently performed by the Oak Ridge Nuclear Data Project (US/NDP). The transfer will be accomplished in several stages, with completion planned on or before July 1, 1981. The intermediate goals are:

| | | |
|---|---|---|
| 1. Nuclear Structure References | October | 1980 |
| 2. Network Service and Support | January | 1981 |
| 3. Nuclear Data Sheets Publication | July | 1981 |

On or about October 1, 1980, the literature scan, file maintenance, and publication functions relating to the Nuclear Structure Reference file will be transferred to US/NNDC. Before that date US/NNDC will

1. Develop an input processing system including a program to extract indexing variables from the keyword entry.
2. Upgrade its present data base and associated processing programs.
3. Develop network service programmes.

Before January 1, 1981, US/NNDC intends to assume the mass-chain evaluation support functions currently being performed by US/NDP. In this capacity, US/NNDC will handle all processing and checking of network evaluations in ENSDF format. Only when ready for publication will they be forwarded to US/NDP for manuscript preparation. Toward that end, US/NNDC will

continued ...

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Toward that end, US/NNDC will:

1. Make operational the present US/NDP plotting programme and replace the data sheets generator (NDSLST).
2. Upgrade if necessary our current data base and associated processing programmes.
3. Develop format and physics checking programmes.

Finally, the Nuclear Data Sheets publication activity will be transferred to NNDC before July 1, 1981 completing the contemplated reorganization of responsibilities within the U.S. for nuclear structure data evaluation activities.

Future Services to the International NSDD Network

The U.S. will continue to support the international nuclear structure evaluations network members in the areas now being covered by US/NDP. During the transfer, US/NNDC will attempt to make improvements which have been requested, recognizing that the first responsibility is to accomplish the transfer of existing US/NDP capability. Sufficient manpower will be allotted to assure that future improvements required by the network can be made.

Training sessions for new evaluators will be held at BNL as needed in collaboration with US/NDP.

The network expressed concern over this development and hoped that it would not cause a loss of continuity in the evaluation coordination procedures established at the 1976 and 1977 NSDD meetings. As the transfer of responsibilities in the U.S. brought about a regrettable loss of experienced evaluators, the network reconfirmed the need to compensate for this loss by strengthening the international network of mass-chain evaluators.

## A.4. Current Mass-Chain Evaluation Status

The mass-chain evaluation status as of April 1980 is given in Table I. As shown in the Table, 53 mass-chains are not being evaluated in the current 1978-1981 4-year cycle, this implies that the network is currently on an approximate 5-year mass-chain evaluation cycle.

Table I: Mass-Chain Evaluation Status as of April 1980

| Network Members | # | Completed Evaluations since end of 1977 | On-Going Evaluation | Evaluations planned through 1981 | Mass Range Responsibilities |
|---|---|---|---|---|---|
| US/NNDC | 0 | (112), 136, 140-145 | 138, 139 | 137 | 136-145 |
| US/NDP + Franco-Belgian Group and Sweden | 23 | 46, 48, 49, 51, 52, 54, 60, 62-64, 101, 103, 105, 109, 111, (112 done by US/NNDC), 117, (119), (147), (154), 195, 196, 197, 199-207, 209, 211-213, 217, 221, 225, 229, 233, 237, 241 | 102, 104, 106, 107, 108, 113, 114, 115, 116, (152), 208 | 110<br>210<br>215-230<br>245-263<br>(excluding seven α-decay mass-chains 217, 221,....,241) | 45- 64<br>101-117<br>195-263<br>[Except masses 238, 240, 242, 244] |
| LBL | 21 | (147 done by US/NDP), 163, 191 | (152 being done by US/NDP), 174, 188, 189, 190, 192, 193 | 168-171<br>180-183 | 146-152<br>163-194 |
| INEL | 2 | (154 done by US/NDP), 159 | 153, 157, 158 | 155, 160, 161 | 153-162 |
| UK + Kuwait | 2 | 70, 71, 73, 77 | 67, 68, 72, 75, 78, 80 | 69, 74, 79, 76 | 65-75, 76-80 |
| FIZ | 4 | 84-87, 91, 92 | 93, 95, 96 | 81, 82, 94, 97-100 | 81-100 |
| USSR/CAJaD | 0 | | 1, 3, 240, 242, 244 | 2, 4, 238 | 1-4, 238, 240, 242, 244 |
| USSR/LIYaF | 0 | 134 | 130, 133, 135 | 131, 132 | 130-135 |
| UTRECHT | 0 | 21-44 | 21-44 | 21-44 in 1983 | 21-44 |
| US/Penn | 0 | 5-12, 18-20 | 13-15 | 16, 17 | 5-20 |
| JAPAN | 1 | (119 done by US/NDP), 121, 123, 125, 127 | 126, 128, 129 | 118, 120, 122, 124 | 118-129 |
| Total # | 53 | = Number of mass-chains not being evaluated in the 4-year cycle 1978-1981 | | | |

## A.5. Mass-Chain Assignments

### A.5.1. New Groups

In an effort to compensate for the loss of evaluators in the U.S. (see A.3. above), and to reduce the evaluation cycle time (see A.4. above), the network was asked to investigate if there existed appropriate groups interested to participate in the mass-chain evaluation effort.

Action 7

The network officially welcomed the participation of two new evaluation groups:

The Franco-Belgian Group: consisting of evaluators at the CEA-Grenoble (FR/CEA-Grenoble) and Orsay (FR/CEA-Orsay) in France, and at the University of Gent in Belgium (BLG/Gent); commitment for masse A=101-117 (except 113).

The Canadian Group: consisting of evaluators at the Tandem Accelerator Laboratory, McMaster University in Hamilton, Ontario (CAN/TAL); Provisional commitment for masses A=149 and 151, subject to confirmation at the next meeting.

### A.5.2. Manpower Commitment

The revised "Manpower Commitment of Evaluation Groups" as of April 1980 is shown in Table II. The Table shows that at the present time there are approximately 22.5 evaluator man-years (not counting support staff) committed to this international effort.

Table II

Manpower Commitment of Evaluation Groups
(As of April 1980)

| Evaluation Group | Manpower Commitment (given in man-years (MY) of evaluator time) |
|---|---|
| US/NNDC | 1 1/2 MY plus 1 or 2 support |
| US/NDP | 3 1/2 MY plus 1 support |
| US/LBL | 2 1/2 MY plus 1/2 support |
| US/INEL | 1 MY plus 2 support |
| US/UP | 1/2 MY plus 1/2 support |
| USSR/CAJaD | 3 MY plus support staff } plus contracts with other organizations |
| USSR/LIYaF | 1 MY plus support staff } plus contracts with other organizations |
| NED/UTRECHT | 2/3 MY |
| UK/LIVERPOOL | 1 MY |
| FRG/FIZ | 3 MY plus 1 support |
| JAP/JAERI | 1 MY plus support staff |
| SWD/Lund | 1/2 MY |
| KUW/ISR | 1 MY |
| FR/CEA+BLG/Gent | 1 1/2 MY plus support staff |
| CAN/TAL | 0.8 MY plus support staff |

A.5.3. Current Mass-Chain Assignments

The assigned responsibilities for mass-chain evaluation, revised by the NSDD network at this meeting are listed in Table III. The guidelines for the reassignment of primary evaluation responsibilities, which were included in the Summary Report of the November 1977 meeting, are reproduced below.

It was suggested that priority criteria in the choice of mass-chains to be evaluated be discussed at the next meeting.

PRIMARY RESPONSIBILITY FOR MASS-CHAINS

Basic scientists have always attempted to work freely on any research problems which interest them. However, in the case of a service activity such as the preparation of evaluation of nuclear structure and decay data, there must be some agreed upon efficient procedures for coordinating the work of many groups of nuclear scientists.

Although continued responsibility for the same mass-chains is considered to be most efficient, transfer of primary responsibility may be necessary to sustain interest of the centres concerned in the evaluation effort and to insure long-term success of the cooperative programme.

Some Comments on the Reassignment of Primary Responsibility

1) If a centre falls substantially behind in its programme for two successive years.
2) If a centre requests a reduction.
3) An existing centre must have a good record to qualify for an increase in its mass-chain responsibility.
4) New groups should start by collaborating with the existing centres.
5) Reassignments can be made bilaterally between existing centres.
6) Formal acceptance of such reassignments should take place at IAEA meetings with advance notice of mass regions of interest.

A.5.4. Network Membership

The list of all active and potential members of the NSDD network is given in Appendix 31.

It was agreed at the May 1976 NSDD meeting, that communication between network members should be in the form of NS-Memoranda carrying a designator identifying the originating centre by its code (see first column of Appendix 31). Each memorandum should therefore bear the following heading

NS-Memorandum-xx/n

where xx is the code of the originating centre and n is the number of the memorandum sent by that centre. Copies of all memoranda should be sent to IAEA/NDS.

Table III

Mass-Chain Assignment as of April 1980

| A-Range | Responsible NSDD Evaluation Groups |
|---|---|
| 1 -4 | USSR |
| 5 -20 | US/UP |
| 21 -44 | NED/UTRECHT |
| 45 -64 | US/NDP |
| 65 -80 | UK/Liverpool (including KUW/ISR) |
| 81 -100 | FRG/FIZ |
| 101-117 | FR-BLG (SWD/Lund completing 113) |
| 118-129 | JAP/JAERI |
| 130-135 | USSR |
| 136-145 | US/NNDC |
| 146-152 | US/LBL (including Canada) |
| 153-162 | US/INEL |
| 163-194 | US/LBL |
| 195-237 | US/NDP |
| 238, 240, 242, 244 | USSR |
| 239, 241, 243 | US/NDP |
| 245- | US/NDP |

A.6. Re-Examination of Evaluation Procedures

A.6.1. Mechanics of Evaluation

The mechanics of evaluation, as described in Appendix 25 of INDC(NDS)-92 (Summary Report of November 1977 meeting), are reproduced below as revised by the network at this April 1980 meeting.

The transfer of the NSDD data base and publication functions from US/NDP to US/NNDC which are to be effected in 1981, will not affect these normal mass-chain evaluation procedures. A new version of these procedures, reflecting the transfer of responsibilities to US/NNDC will be submitted by US/NNDC to the network.

Action 9

A.6.2. Review Procedures

The review procedure adopted at the November 1977 IAEA NSDD meeting has worked well and no changes are proposed. There has not been any occasion to invoke the arbitration clause in the review procedures and all matters were resolved between the editor, evaluator and the referee. All A-chains, except for A = 5-44, including those from NDP evaluators, are now reviewed. The adopted "Review Procedures" are listed below.

## NORMAL PROCEDURE FOR MASS-CHAIN EVALUATION

1. Author notifies US/NDP that evaluation is beginning for A = **

2. NDP sends to Author:

   a) Complete indexed reference list for nuclei with A = **,
   b) Complete listing of ENSDF card-images for A = **,
   c) NDSLIST listing of all ENSDF data for A = **.

3. NDP begins regular monthly distribution of new references on A = **

4. As evaluation proceeds:

   a) Unusual documents are obtained by Author from NDP,
   b) Copies of private communications and other unusual sources are sent by the Author to NDP for keynumber assignment and for inclusion in the NDP library,
   c) Parts of an A-chain may be sent to NDP (cards or tape) for processing with NDP programmes which are not available locally.

5. When the evaluation is complete, the Author will send all data sets for A = ** to US/NDP, together with a complete card listing.

6. NDP will merge the data sets onto a temporary file, after correcting any serious format errors. (All changes will be marked on the Author's original card listing).

7. NDP will prepare from the submitted data sets:

   a) Preliminary NDSLIST, including tables of all data types from all data sets, in ENSDF-index order,
   b) Preliminary drawings, including a drawing for each data set and a summary drawing for the entire mass-chain,
   c) Preliminary reference list.

   NDP will also perform certain standard calculations and consistency checks on the submitted data sets. The preliminary manuscript and all relevant printouts will be sent to the Author, together with the Author's original card listing (marked as necessary) and two copies of the current card listing.

   If these preliminaries suggest that major revisions of the data sets may be required, NDP will also return a tape copy of the current data sets, together with some general comments about how the data sets must be improved. After the data sets have been expanded or corrected, the mass-chain should be resubmitted to NDP as in item 5, above.

8. The Author will inform the Editor of Nuclear Data Sheets when the data sets for A = ** are complete. An abstract for the data evaluation and a copyright-release letter must also be sent to the Editor.

continued ...

Normal Procedure for Mass-Chain Evaluation - continued

9. NDP will prepare 2 copies each of:
   a) Semifinal NDSLIST, including tables of data prepared in the standard order for Nuclear Data Sheets,
   b) Semifinal drawings organized into page layout,
   c) Semifinal reference list with all keynumbers identified,
   d) Preliminary abstract page.

   One copy will be sent to the Author; the other copy will be assigned to a Referee for review (see Section G.2.C. in main body of report).

10. The Referee will send to the Editor a report on the review of the submitted manuscript for "Nuclear Data Sheets for A = **".
    a) If the manuscript is acceptable for publication in Nuclear Data Sheets, as regards completeness and correctness, the Referee's report will recommend prompt publication.
    b) If the manuscript is generally satisfactory, but contains certain errors or omissions, the Referee's report should document the problems in sufficient detail that the Author can take remedial steps.
    c) If the first few pages of a manuscript contain substantive or systematic errors, the Referee may reject it without further examination. Clear justification must be presented in the written Referee's report.

11. If a manuscript has been recommended by the Referee as acceptable for publication in Nuclear Data Sheets (10a, above):
    a) The Editor will promptly notify the Author, and assign a tentative publication data,
    b) Last-minute corrections of typographical or other minor errors should be sent by the Author to NDP,
    c) The Editor may also authorize changes in grammar, spelling, punctuation, and layout as may be required to ensure a uniform high quality for Nuclear Data Sheets (any such changes will be reported to the Author),
    d) The Editor shall send the final manuscript to the Author for final proof-reading in case of significant changes; final changes or corrections shall be submitted to the Editor by the Author, preferably within a week of receipt,

continued ...

Normal Procedure for Mass-Chain Evaluation - continued

e) The manuscript is now accepted for publication in Nuclear Data Sheets, and the Author's commitment to revise "Nuclear Data Sheets for A = **" has been completed,
f) NDP will prepare final manuscript for publication. Five preprint copies will be sent to the Author at the same time photoready copy is sent to the publisher.

12. If the Referee has suggested minor changes (10b, above):
    a) The Editor will consider the referee's comments, and send a copy of the Referee's report to each Author,
    b) The Author should mark data set revisions on one copy of the ENSDF card listing and return it to NDP,
    c) NDP will make the changes and prepare a revised semi-final manuscript (item 9, above), a copy of which will be sent to the Author,
    d) The Editor may accept these changes as complying with the Referee's recommendation, or the Editor may make further consultation with the Author and the Referee until an acceptable manuscript is prepared. The manuscript is then processed as in item 11, above.

13. If the manuscript requires major revisions (10c, above):
    a) The Editor will consider the Referee's comments, and send a copy of the Referee's report to each Author,
    b) The Author will make modifications at his own institution, and the manuscript should be resubmitted as in item 5, above,
    c) The Editor may ask for a second Referee's opinion and proceed as in item 10, above.

14. After a manuscript has been accepted for publication in Nuclear Data Sheets, the Author is required to:
    a) Inform NDP about disposition of older information contained in ENSDF (in principle, all older data sets have been superseded and may be deleted),
    b) Provide NDP with data sets (if any) to be preserved in the "working file" of (unevaluated) experimental data,
    c) Inform NDP about changes in status for reference-file entries. (This will provide the most reliable means of flagging unimportant, incorrect, or superseded references).

15. If the Author believes that changes suggested by the Referee are not justified or are incorrect, an appeal may be made through the Editor using the established arbitration procedure.

In order to adequately taking into account the effects of the transfer of responsibilities from US/NDP to US/NNDC in the course of 1981, a revised "Review Procedure" is to be proposed by US/NNDC and distributed to the network before the next meeting.

Action 9

In this regard, the meeting accepted the following statement:

> It is the general view of the network that the responsibility of the Editor of the Nuclear Data Sheets, as described in the "Review Procedures" listed below, should be assumed by the Editor-in-chief. Delegation of part of these responsibilities to other editors, Associate Editors or Technical Editors may be profitable.

REVIEW PROCEDURES

(i) Every A-chain to be published in the Nuclear Data Sheets journal will be refereed.

(ii) Editor
It is the Editor's responsibility to select referees, send evaluations and guidelines to referees, consider referees' comments, send those comments which in his judgement are pertinent within the established guidelines to evaluators, consider evaluator's response, and supervise the review procedure (see below).

The Editor will be selected from the Nuclear Data Project.

(iii) Referees
a. The referee should be an experienced nuclear scientist from the international community.
b. A scientist should preferably not be asked to referee more than one A-chain per year.
c. NDP staff will referee the first A-chain from every new evaluator.
d. Referee's comments and objections must be specific.
e. In no case will a Referee rewrite an A-chain.
f. Referee will be anonymous.

(iv) Arbitration
The responsibility of resolving disagreement between authors and referees is assigned to the Editor.

The Editor will consult with other experienced evaluators of NSDD to resolve such disagreements.

For the present, the Editor retains authority to make final decisions about the content of Nuclear Data Sheets.

(v) These review procedures will be re-examined at the next IAEA NSDD Meeting.

In order to assure good quality in evaluation, particularly as the number of A-chains evaluated per year is likely to increase, it was agreed by the network that help from as many experienced nuclear scientists should be solicited for refereeing purposes. Both, the Division of Nuclear Physics of APS and the European Physical Society have been approached for this purpose. The network was also requested to inform the Editor of Nuclear Data Sheets of the names of potential referees.

Action 10

A.6.3. Procedures to Assure a Four-Year Cycle

The following revised procedures were adopted by the network.

PROCEDURES FOR ASSURING A FOUR-YEAR CYCLE

(i) Each year, all NSDD centres will be requested by US/NNDC to send their evaluation schedules for the next two years to IAEA/NDS and US/NNDC. Each centre would be expected to give highest priority to the most out-of-date A-chain in their region.

(ii) If a centre fails to meet its scheduled evaluations at the end of the year, this information will be given to the NSDD Network.

(iii) In consultation with the IAEA/NDS, US/NNDC will contact the centre concerned and encourage it to make an increased short-term effort to regain temporary reassignment of the deficient mass-chains in their commitment.

(iv) If a centre is unable to make the necessary special commitment before mid-year, US/NNDC, in consultation with IAEA/NDS will attempt to arrange for temporary reassignment of the deficient mass-chains. This reassignment is for one revision only, and will not normally affect the centre's formal commitment.

## A.7. Publication of NSDD

### A.7.1. Nuclear Data Sheets

The meeting participants discussed presentation of the data (i.e. distribution of information on the printed page) in Nuclear Data Sheets in context of ENSDF-associated computer programmes (see Agenda Item A.10). Additional considerations are also pointed out on the second page of Appendix 23.

In view of the expected increase in the volume of evaluations published in Nuclear Data Sheets, the meeting concluded that consideration should be given to compacting information in Nuclear Data Sheets, and that this question be considered at the next meeting.

### A.7.2. Wall Charts of Nuclides

The following Wall Chart publication plans were announced:

- Federal Republic of Germany: the next edition of the wall chart produced at the Kernforschungszentrum Karlsruhe will be published early in 1981. Approximately 35 000 copies of the Karlsruher Nuklidenkarte are sold and distributed. In addition, the same number of charts are also sold in booklet form.

- Japan: a revised edition of the Japanese Chart of Nuclides will be published around March 1981.

- United States: the next edition of the wall chart published by General Electric will be produced at the end of 1982. In the United States, 50 000 copies of the Chart of the Nuclides are distributed free of charge, in addition it is also sold in book form.

- USSR: the USSR member of the network was asked to inquire about the status of the USSR wall chart effort.

Action 18

In addition to the general concern of the network that all wall charts use the same information sources, it was also suggested that the subject of presentation of information on wall charts (e.g. N versus Z and Z versus N) be discussed at the next meeting.

### A.7.3. Radioactivity Handbook

A Radioactivity Handbook for applied users is planned to be produced on behalf of the US Nuclear Data Network by the Isotope Project at the Lawrence Berkeley Laboratory (US/LBL). The Handbook will be produced at four year intervals, beginning in 1982; data will be taken from the current version of ENSDF file supplemented by calculated and evaluated properties not included in ENSDF. The proposed outline of the Radioactivity Handbook is given in Appendix 16.

In order to determine the needs and requirements of the community of applied users, US/LBL distributed approximately 5 000 questionnaires concerning the content and format of the proposed Radioactivity Handbook. The results of this survey are given in Appendix 17.

The network was also asked to complete the survey questionnaire regarding the Radioactivity Handbook.

Action 19

Following extensive discussions on the content and format of the Handbook, the network concluded that the Radioactivity Handbook should take the needs of applied users into account.

A.7.4. Compilation of Evaluations

Three separate compilations of nuclear data compilations and evaluations are produced by members of the NSDD network:

- The "Compilation and Evaluation of Nuclear Structure and Decay Data", published annually by the IAEA Nuclear Data Section; the fifth issue is to be distributed in May 1980. Each issue supersedes the previous one. The scope is restricted to nuclear structure and decay data.

- The "Data Compilation in Physics", published by the Fachinformationszentrum Energie, Physik, Mathematik GmbH in the Federal Republic of Germany. First volume published in 1976, supplements issued yearly, scope covers all fields of physics.

- "A Source List of Nuclear Data Bibliographies, Compilations and Evaluations", published by the United States National Nuclear Data Centre, at the Brookhaven National Laboratory. First issue was published in August 1977 as report BNL-NCS-50702. New issue to be published in 1980, scope covers all fields of nuclear physics.

In response to an action on US/NNDC to inquire about the possibility to include the content of one of the three compilations on Evaluations in the ADNDT journal, the Editor of ADNDT decided against it.

In order to assure uniform coverage, it would be desirable to have the files of each of the three centres producing these compilations, available to each of the other centres.

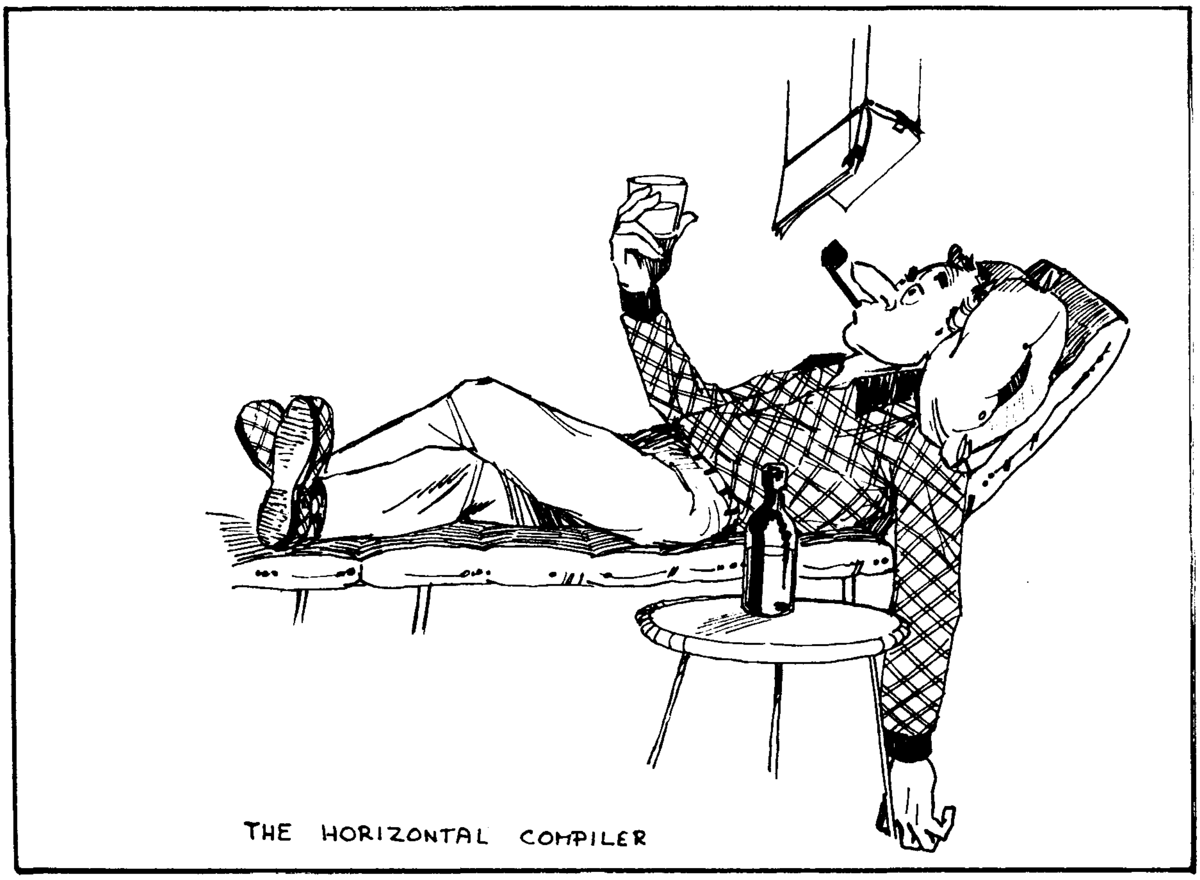
A.7.5. Horizontal Compilations

Discussion on horizontal compilations (see Definition of Terms, page iii) brought out the concern that there should be a feed back of information to the ENSDF file. This resulted in the following Recommendation.

| |
|---|
| Authoritative horizontal evaluations (e.g. atomic mass evaluation by Wapstra and Bos) should be adopted for use by the NSDD network. |

Meeting participants were requested to send detailed information on new horizontal compilation.

Action 21




(Courtesy Utrecht University)

## A.8. Status of the Nuclear Structure Reference (NSR) File

### A.8.1. Description of the NSR File

The Nuclear Structure Reference File is the comprehensive compilation of keyworded bibliographic NSDD references used for the periodic publication of Recent References in the Nuclear Data Sheets journal, for the preparation of special collections of bibliographic citations for special topics (including all reference lists for the mass-chain evaluations published in Nuclear Data Sheets), and for the preparation of responses to inquiries for specific nuclear information. The NSR file has keyworded information back to 1960. A description of the NSRF was published in 1978 by W.B. Ewbank in ORNL-5397.

As part of the transfer of the Recent References activity from US/NDP to US/NNDC, NNDC has begun to convert the present ADSEP format NSR file into the format (still ADSEP in structure) described in Appendix 18. At the same time the selector (indexing) entries will be regenerated. A program to extract selector entries from the keyword string has been compiled and extensively tested. Any errors detected during the conversion will be corrected.

The ability to retrieve references has been augmented by distinguishing between the target and product nuclei in the file. The measured, deduced, calculated and evaluated quantities are also properly linked.

In response to J. Blachot's proposal (see Appendix 19), US/NNDC suggested that a separate file in an ENSDF-like format be maintained by US/NNDC. This file would be distributed to the network at the same time as the regular ENSDF distribution. It would consist of one ENSDF data set per mass-chain sorted by mass number. The set would consist of an ID record, one record for each reference cited in the mass-chain sorted by keynumber and a terminating (blank) card.

| An example: | col. 8 ↓ | | ↓ Col. 10 |
|---|---|---|---|
| | 111 | | REFERENCES |
| | 111 | R | 63AB03 JOUR ZPAAD A110 35 |
| | 111 | R | 72NA35 JOUR JUPSA 21 355 |
| | 111 | R | 75KRZA REPT LBL-3728,P21 |
| | | | (blank card) |

Network evaluators would not be required to provide this reference file. It would be produced by US/NNDC from the ENSDF file for that mass-chain during the prepublication processing at US/NNDC. Implementation would be made during 1981. This proposal was accepted by the network.

### A.8.2. Distribution of the NSR File

The NSR file is distributed regularly to the following centres: USSR/CAJaD, UK/Liverpool, FRG/FIZ, IAEA/NDS, and JAP/JAERI.

At the time of the transfer of responsibility for Recent References to US/NNDC (Oct. 1, 1980), US/NNDC will send to all recipients of the NSR tape, a complete new file in the revised format. It will contain all entries in the file on that date. Thereafter, at four months intervals (or more frequently if requested by the network), US/NNDC will transmit updates to the file for that interval. Specialized retrievals for network evaluators will be initiated at NNDC as soon after that date as possible. Initial priority will be given to assuring the continuity of the compilation activity over the transaction period of the transfer.

Earlier versions of the NSR file have been distributed to the network according to the following schedule:

| Version | Coverage | # Records | Date Received at US/NNDC |
|---|---|---|---|
| 1/77 | 1969 - 1976 | 206,413 | 4/ 5/77 |
| 1/78 | 1910 - 1977 | 839,450 | 10/ 8/78 |
| 1/79 | 1910 - 1978 | 1,023,176 | 10/22/79 |
| 1/79 | Additions during Jan-July 1979 | | 11/13/79 |
| 1/80 | 1910 - 1978 (corrected version) | 988,280 | 2/ 3/80 |
| 1/80 | Additions during Jan-Dec 1979 | 64,031 | 4/ 1/80 |

A.8.3. Purging of the NSR File

As a result of discussions on the purging of the NSR file and errors in "Recent References", it was agreed that anyone who identifies errors in the keywords used in "Recent References" should communicate them to US/NNDC and US/NDP.

Action 23

Also, all evaluators were asked to help clean up the NSR file in the process of evaluation, by informing US/NNDC of the identified errors.

Action 24

## A.9. Status of ENSDF

### A.9.1. Description of ENSDF

The Evaluated Nuclear Structure Data File (ENSDF) is the computer-based file for all nuclear structure and decay data compiled, evaluated, exchanged, published and disseminated by the international NSDD network. The ENSDF is made up from a collection of "data sets", each of which describes the results of a single experiment or the combined evaluated results of a number of experiments of the same type. It is designed to be used as a storage file for compiled and evaluated data, as a source file for specialized output and publications, and as a vehicle for the exchange of data among the members of the NSDD network.

A.9.2. ENSDF System

A.9.2.1. Proposed Technical Changes in ENSDF System

(i) Proposal to abolish the Format card (see Appendix 20) led to the following Recommendation.

| |
|---|
| Abolish the use of the F- (format)card in ENSDF in the course of the next four years |

(ii) Proposal to include delayed particle emission data in ENSDF (see Appendix 20) led to an action to write a proposal to this effect.

Action 31

(iii) Request to replace the Hager-Seltzer Tables in the HSICC programme by new improved conversion coefficient tables led to an action on US/NNDC to inform the network when this will have been done.

Action 25

A.9.2.2. Physics Content of ENSDF

(i) Concern of the completeness of ENSDF, particularly with regard to mass-chain data in the A = 5-44 mass-chain range which are not automatically entered into the ENSDF system, led to the assignment of responsibilities to organize this effort.

Action 28

(ii) Concern over the correctness of data in ENSDF resulted in an action on all evaluators to communicate identified mistakes to the appropriate centres.

Action 29

A.9.2.3. Uniformity and Improvement of Evaluation Standards

(i) Suggestion to have additional "minimum standards" to be used as guidelines by evaluators resulted in an action for the network.

Action 26

(ii) The network was also asked to keep the Nuclear Data Sheet list of symbols and Abbreviations under constant review.

Action 27

A.9.2.4. Acknowledgement of ENSDF Evaluation Responsibilities

In considering the acknowledgement of ENSDF evaluators, the meeting participants made the following Recommendation.

| |
|---|
| The assigned responsibilities for mass-chain evaluation, as well as instructions to authors of horizontal evaluations, should be displayed prominently in every issue of the Nuclear Data Sheets. |

A.9.2.5. Guidelines for Referring to ENSDF as a Reference

In order to allow for a universally accepted manner in which ENSDF users should reference the entire ENSDF file, or selected information contained in ENSDF, the network adopted the following "Reference Guidelines for ENSDF", and suggested that these guidelines be sent together with ENSDF retrievals or transmissions to all ENSDF requestors.

Action 32

## REFERENCE GUIDELINES FOR ENSDF

Case 1: Use of ENSDF evaluations in a secondary manner (where many data sets are used together). In this case we propose the following form

> "Evaluated Nuclear Structure Data File edited and maintained by the Nuclear Data Project, Oak Ridge National Laboratory, on behalf of the International Network for Nuclear Structure Data Evaluation (March 1980). Summary of file contents and published documentation may be found on page iii of any issue of the Nuclear Data Sheets".

The date of the file is included with this transmittal.

Case 2: Use of conclusions or adopted values in ENSDF. We propose, for A = 84 from ENSDF as an example:*

> "ENSDF data file for A = 84 edited and maintained by the Nuclear Data Project, Oak Ridge National Laboratory, on behalf of the International Network for Nuclear Structure Data Evaluation. Nuclear Data Sheets for A = 84, H.-W. Mueller and J.W. Tepel, Nuclear Data Sheets **27**(3), 339(1979)."

A list of appropriate references to ENSDF documentation is enclosed with this transmittal.

Case 3: Use of private communications or errata communicated to the evaluators. We propose, for A = 84 from ENSDF as an example: *

> "Private communication from J. van Klinken, *et al.* Cited by the ENSDF data file for A = 84, edited and maintained by the Nuclear Data Project, Oak Ridge National Laboratory, on behalf of the International Network for Nuclear Structure Data Evaluation. Nuclear Data Sheets for A = 84, H.-W. Mueller and J.W. Tepel, Nuclear Data Sheets, **27**(3), 339(1979)."

A list of appropriate references to ENSDF documentation is enclosed with this transmittal.

---

* In most cases the reference to ENSDF is redundant and should be omitted. However, there are several cases, where it should be included. These are:

1. If the data file has not been published (*e.g.* A = 3).
2. If the data file contains data which did not appear in the publication (*e.g.* A = 156).
3. If the data file has been prepared for ENSDF by persons other than the evaluators (*e.g.* A = 5 to 44).
4. If there has been an interim evaluation of part of these data file (*e.g.* M. Martin's and D.C. Kocher's work).

### A.9.3. ENSDF Distribution

ENSDF is distributed to the following centres on a regular basis: JAP/JAERI, USSR/CAJaD, USSR/LIYaF, IAEA/NDS, NEA/DB, FRG/FIZ, and UK/Liverpool.

ENSDF has been distributed twice a year during 1978 and 1979 to the network data centres.

| ENSDF Version | Data received* at NNDC | No. of Records |
|---|---|---|
| 1/78 | 2/16/78 | 222 561 |
| 7/78 | 8/31/78 | 258 613 |
| 1/79 | 3/12/79 | 287 867 |
| 7/79 | 8/20/79 | 297 920 |
| 1/80 | 3/ 3/80 | 326 414 |

The index to the current content of ENSDF on microfiche was distributed to the meeting participants. Copies of the ENSDF index on microfiche are available from US/NNDC.

### A.9.4. ENSDF Working File

In addition to the ENSDF master file, the existence of another file in ENSDF format has been foreseen for the convenience and optional use of NSDD network members.

This working file has been suggested to be used for the following purposes:

- the re-cycling of mass-chain evaluations,
- the storage of selected groups of data for analysis or evaluation by standard ENSDF processing programmes,
- for the storage of data compiled when performing horizontal evaluations,
- for the storage of data published in preprints and laboratory reports having limited distribution,
- the storage of preliminary or alternate mass-chain evaluations, and
- for the storage of experimental data sets that were considered to be the best supportive evidence not included in the final evaluation and which should be considered by evaluators for the next evaluation.

To date, the only evaluator group who has contributed to this file seems to be the NNDC who sent 10 data sets each for the mass-chain evaluations A = 143, 144 and have recently prepared over 20 data sets for A = 112 and A = 136. US/NNDC indicated that no other evaluator has sent similar information pertaining to their evaluations.

To supplement the publication of NSDD in Nuclear Data Sheets and Nuclear Physics A, the network's data service centres distribute both bibliographic and numerical NSD data on request primarily to applied users all over the world. In addition to the distribution of the entire NSR and ENSDF files, some of these centres have the capability to make selective retrievals from these files and provide specialized output.

As a result of considerable interest shown by the network in the availability of the MEDLIST output from ENSDF, US/NDP was asked to distribute this output to the network.

Action 37

In addition, US/NDP has also merged into this file data information sets generated for special requests or purposes e.g., α-hindrance factors etc.

An index of the working file as it stands now has been requested and will be distributed to the network soon.

The meeting participants discussed the uses and content of the working file without any specific conclusions, other than deferring further discussion to the next meeting.

A.10. Status of NSDD Computer Programmes

The current status and availability of ENSDF-associated computer-programmes developed by US/NDP and US/NNDC are shown in Table IV.

The network was asked to send comments and suggestions to US/NNDC on the specifications of both the "Format" and "Physics" checking programmes in response to the proposed specifications which are to be sent by US/NNDC to the network.

Action 34

Action 35

The network restated last meeting's Standing Action #2, for all NSDD centres to distribute to other centres computer codes which could be useful to other members of the network.

Action 39

A new ENSDF retrieval programme, INKARET, developed by FRG/FIZ, was discussed by the network. The programme is described briefly in Appendix 21. In view of the versability of the INKARET programme, it was suggested that it be made available to the members of the network.

## A.11. NSDD Data Centre Services

As the principal NSD data distribution centre, US/NNDC, in addition to providing routine NNDC and other nuclear data service to the NNDC service area, is responsible to provide the following services to the mass-chain evaluators world wide:

- Retrospective bibliographic retrievals for the mass-chains of their responsibility.
- Monthly bibliographic updates for their respective mass chains.
- Specialized library services, e.g. hard to find reference.
- Existing entries in ENSDF for the A-chain under review.
- Data checks, editing, and review of the new evaluation.
- Publication of new evaluations appropriate for Nuclear Data Sheets.
- Maintenance of ENSDF and NSR Files and selected computer codes.
- Regular distribution of the complete ENSDF and NSR files and selected computer codes.

A sample "Service Request Form for NSDD and Related Information", which is designed to be used to request data from US/NNDC is shown as Appendix 22.

Table IV

Current Status and Availability from US/NNDC

of ENSDF-Associated Computer Programmes

| Name | Short Description | Language | Machine | Availability |
|---|---|---|---|---|
| **A. Analysis Programs** | | | | |
| i) HSICC | Interpolate conv. coeff. | Fort | IBM,DEC,CDC | Now |
| ii) LOGFT | Calculate logft, etc. | Fort | IBM,DEC,CDC | Now |
| iii) DLOGFT<br>iv) | Double precision version of (ii) | Fort | IBM,DEC,CDC | Now |
| iv) GTOL | Determines level energies, intensity balance, etc. | Fort | IBM,DEC,CDC | Now |
| v) ANGCOR | Determines spins, multipole mixing, etc. from ang. corr. | Fort | IBM,DEC,CDC | Now |
| vi) HSMRG | Merge cards created by (i) into input deck | Fort | IBM,DEC,CDC | Now |
| vii) MEDNEW/MEDLIST | Calculate radiations, energy balance, modify to ENDF | Fort | IBM,DEC | Now |
| **B. ENSDF Maintenance** | | | | |
| NDP-Version | Add, delete, change records | PL/1 | IBM | Now |
| NNDC-Version | Add, delete, change records | Fort | DEC | Now |
| **C. Retrieval** | | | | |
| NDP-Version | Retrieve data from ENSDF | PL/1 | IBM | Now |
| NNDC-Version | Retrieve data from ENSDF | Fort | DEC | 12/80 |
| Bibliographic | Retrieve references from NSR | Fort/ | DEC | 12/80 |
| NDSLIST | Produce NDS from ENSDF | PL/1 | IBM | Now |
| Preplot/Plot-NDP | Draw plots from ENSDF | Fort/ DISSPLA | IBM | Now |
| **D. Checking Programs** | | | | |
| Format (to be developed) | Check A-chains for format energy | Fort | DEC | 12/80 |
| Physics (under development) | Some physics checks | Fort | DEC | 12/80 |
| **E. Libraries** | | | | |
| String handling routines-NDP | Character string handling | Assembly | IBM | Now |
| String handling routines-NNDC | Character string handling | Fort | IBM,DEC,CDC | Now |

B. Physics of NSDD Evaluation

Two papers (Appendix 23 and Appendix 24) which contained general remarks on the format and presentation of Nuclear Data Sheets, were presented to the meeting. The paper by Endt (Appendix 23) served in particular as the basis for discussions throughout the afternoon sessions of the meeting.

B.1. Terminology

The following topics which have to do with the common usage of terms, definitions, notations, symbols and abbreviations were discussed:

(i) It was agreed to endorse the use of definition of terms defined at the May 1976 NSDD Meeting. The list of agreed definitions is included on page iv at the beginning of this report.

(ii) It was agreed to have IAEA/NDS distribute the IUPAP list of terminology and definitions to the network for consideration at the next meeting.

Actions 11 and 12

(iii) Discussion of the sign convention for δ (the ratio of reduced matrix elements of (L+1)- to L-pole radiation) led to actions to have a combined list of common sign conventions distributed to the network for consideration at the next meeting.

Actions 13 and 14

(iv) Consideration of the transition probability symbol B(EL) resulted in agreement by Martin to take appropriate steps to improve the situation.

(v) It was agreed that there should be an indication whether conversion coefficients are experimental, theoretical or derived values.

(vi) As there seemed to be a problem in the uniformity in presenting spectroscopic factors, Endt agreed to write a note on spectroscopic factors for single nuclear transfer and distribute it to the network.

Action 15

In concluding this Agenda topic, it was requested that the network keep the Nuclear Data Sheet list of Symbols and Abbreviations under constant review, and send suggestions for changes to US/NDP.

Action 27

B.2. Nuclear and Decay Properties

B.2.1. Nuclear moments and directly measured spins

The recommendation on the compilation of moments and directly measured spins was presented by Lederer, and is described in Appendix 25. With regard to Lederer's next nuclear moments and spins compilation, which is expected to be finished at the end of 1982, it was suggested that it include (i) adopted values with uncertainties for all moments, (ii) higher moments, (iii) numerical values of correction factors applied to experimental values, and (iv) directly measured spins.

Action 5

The network made the following recommendation to NSDD Evaluators:

> Use the recommended procedures for the quotation of nuclear moments and spins as described in Appendix 25, by V.S. Shirley and C.M. Lederer.

B.2.2. Arguments for spin and parity assignments

The review of the recommendation for the assignment of spin and parity, adopted at the November 1977 NSDD meeting (INDC(NDS)-92, p. 17) resulted in the formulation of a new recommendation regarding strong arguments on spin and parity assignments.

The network revised the four rules (a, b, c, d) on which strong arguments are based, described in Nuclear Physics A 310(1978) 5 by Endt and van der Leun, and recommended that these rules, as revised and adopted by the network, be added to those listed in the Nuclear Data Sheets (page vi). The revised rules were combined in the physics recommendation on Strong Arguments on Spin and Parity Assignment which is given on the next page.

The network was also asked to consider proposed additions, changes and deletions of $J^{\pi}$ assignment rules for discussion at the next meeting.

Action 6

B.2.3. Lifetimes

The proposal on lifetime error quotation, as described in Appendix 23, page 6, was suggested to be adopted and used at the discretion of evaluators for results of low velocity DSA measurements. The suggested guideline reads as follows:

> "If the source paper only lists statistical errors for DSA $T_{1/2}$ results, the compiler should add (in quadrature) a reasonable systematic error, say 15 % ..... The weighted average of several DSA results should not have an error smaller than 10 %".

## Physics Recommendation on Strong Arguments on Spin and Parity Assignments

The following propositions are recommended to be added to the strong arguments on spin and parity assignments.

1. If the angular distribution can be fitted with a unique L-value the $J^\pi$ of the final state is related to the $J^\pi$ of the initial state by $\vec{J}_f = \vec{J}_i + \vec{L}$ with parity change if L is odd, for the following cases:

   i) a strong group observed in (p,t), (t,p), and ($\tau$,n) reactions (two identical nucleons transferred in a relative S-state).

   ii) a strong group observed in the α-particle transfer reaction ($^6$Li,d).

   iii) (e,e') and (α,α') inelastic scattering.

2. In reactions with $J^\pi = 0^+$ target, projectile and ejectile, if the yield of a group at $0^\circ$ or $180^\circ$ is

   i) non-zero, the parity of the final state is $(-1)^{J_f}$

   ii) zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f+1}$

   In reactions with a polarized $J^\pi = 1$ projectile in the m = o substate, with $J^\pi = 0^+$ ejectile and target, if the yield of a group at $0^\circ$ or $180^\circ$ is

   i) non-zero, the parity of the final state is $(-1)^{J_f+1}$

   ii) zero at several uncorrelated energies, the parity of the final state is $(-1)^{J_f}$

B.2.4. LOG ft Values

The paper on the systematics of LOG FT values in β-decay by H. Behrens et al, (Appendix 26) was discussed briefly.

B.2.5. Arguments for Isobaric Spin Assignments in Light Nuclei

Discussion of the paper presented by Endt and van der Leun on "Arguments used for Isobaric Spin Assignments in Light Nuclei" (Appendix 27). Although these rules apply primarily to mass-chains < 45, the network felt that they should nevertheless be included in the Nuclear Data Sheets. Discussion ended with the request to Endt and van der Leun to reformulate the arguments on isospin assignments and to submit them for approval at the next meeting.

Action 16

B.2.6. Gamma-Ray Branchings

The discussion of the note by Tepel "On the Calculation of Adopted Relative Gamma Branchings" (Appendix 28) led to the following

Physics Recommendation on Gamma-Ray Branching

| |
|---|
| The averaging of relative gamma-ray branching should be done by least-squares procedures. |

B.2.7. Gamma-Ray Transitions

Discussion of the propositions on which strong arguments are based for gamma transitions, led to the following changes in the rules given on page (vi) of Nuclear Data Sheets:

(i) deletion of strong rule 7
(ii) replacement of strong rule 6

The adopted revised rules are given below as physics recommendation on "Strong Rules for Gamma-Ray Multipolarity Assignments".

B.2.8. Gamma-Ray Energy Standards

Van der Leun announced that a IUPAP task group, of which he is member, had recommended a list of 100 gamma-ray calibration energies, which have all been measured relative to gold to a precision of better than 10 ppm. The evaluation is to be published shortly in ADNDT. The preprint of this published compilation will be distributed to the network.

Action 1

## Physics Recommendation

### Strong Rules for Gamma-Ray Multipolarity Assignments

M. J. Martin

The following revision to the "Summary of Bases for Spin and Parity Assignments" section of the Nuclear Data Sheets was recommended:

a) Delete strong Rule 7.

b) Replace strong Rule 6 by the following:

The following upper limits on gamma-ray strengths (in Weisskopf units) may be used to rule out the indicated gamma-ray character.

| Character [a] | $\Gamma_\gamma$ (W.u.) | | | |
|---|---|---|---|---|
| | A=6–20 [b] | 21–44 [b] | 45–90 [b] | >90 [c] |
| $E1_{1V}$ | 0.3 | 0.1 | 0.01 | 0.01 |
| $E1_{1S}$ | 0.003 | 0.003 | | |
| $E2_{1S}$ | 100 | 100 | 300 | 1000 |
| $E2_{1V}$ | 10 | 10 | | |
| E3 | 100 | 100 | 100 | 100 |
| E4 | 100 | 100 | 100 | |
| $M1_{1V}$ | 10 | 10 | 3 | 2 |
| $M1_{1S}$ | 0.03 | 0.03 | | |
| $M2_{1V}$ | 3 | 3 | 1 | 1 |
| $M2_{1S}$ | 0.1 | 0.1 | | |
| $M3_{1V}$ | 10 | 10 | 10 | 10 |
| M4 | | | 30 | 10 |

a) The indices 1V and 1S denote isovector and isoscalar character, respectively.

b) From "Strengths of Gamma-Ray Transitions in A = 45–90 Nuclei," P. M. Endt, Atomic Data and Nuclear Data Tables 23, 547 (1979).

c) From the Evaluated Nuclear Structure Data File of the Nuclear Data Project, August 1980.

B.2.9. Resonance parameters

Pearlstein announced the publication of a new edition of the BNL report on neutron resonance parameters. This new compilation will contain only recommended values, and the complete set of data will have been subjected to extensive consistency checks.

The network recognized the value of this compilation for mass-chain evaluators, and felt that it could be used more extensively in mass-chain evaluation, when the basic data were also presented.

## B.3. Philosophy of NSDD Evaluation

B.3.1. Presentation of evaluated NSD data in publications

Extensive discussion and exchange of views. No specific conclusion reached.

B.3.2. Uncertainties

Discussion of the paper on "Nuclear Decay Data: The Statement of Uncertainties", by W.B. Mann (Appendix 29). The network agreed not to support this paper.

B.3.3. Mistakes

Discussion of the paper on the "Role of "Physics" Interpretation in the A-Chain Evaluation Process" by C.W. Reich (Appendix 30). No specific conclusion reached.

B.3.4. Use of word "standard"

Concern was expressed that the word "standard" was often misused or used to mean different things. It was suggested that in context of NSDD the word "standard" be restricted to its more specific meaning, i.e."a reference value established by general agreement as a basis for the measurement of other physical quantities."

B.3.5. Guidelines for evaluators

Martin volunteered to consolidate all existing minimum evaluation standards, and to draft a set of guidelines for mass-chain evaluators. The network was asked to send Martin any suggestions for additional "minimum standards" to be included in the guidelines.

Action 26

B.3.6. Use of unpublished data in evaluations

The network made the following Recommendation:

| |
|---|
| Evaluators should use their own judgement and discretion when adopting values dependent upon unpublished data. Normally such data would not be used when comparable published data are available. Evaluators should be especially cautious when using older unpublished data. |

Appendix 1

List of Participants

(NSDD Network Members Indicated by *)

| | | | |
|---|---|---|---|
| 1. W. Bambynek | | CBNM/Geel | Bureau Central de Mesures Nucleaires<br>Steenweg naar Retie<br>B-2440 GEEL, Belgium |
| 2. H. Behrens | * | FRG/FIZ | Fachinformationszentrum Energie, Physik, Mathematik GmbH<br>Kernforschungszentrum<br>D-7514 EGGENSTEIN-Leopoldshafen |
| 3. J. Blachot | * | FR/Grenoble | Centre d'Etudes Nucleaires de Grenoble<br>Dept. of Fundamental Research<br>Cedex No. 85<br>F-38041 Grenoble Gare, France |
| 4. M. Bogdanovic | | | Boris Kidric Institute of Nuclear Science<br>P.O. Box 522<br>11001 BELGRADE, Yugoslavia |
| 5. F.E. Chukreev | * | USSR/CAYaD | Centr po Atomn. I Jadern. Dannym<br>Institut Atomnoi Energii I.V. Kurchatova<br>Ploshchad I.V. Kurchatova<br>Moscow D-182, 123182, USSR |
| 6. J. Dairiki | * | US/LBL | Table of Isotopes Project<br>Lawrence Berkeley Laboratory<br>Berkeley, California 94720, USA |
| 7. D. De Frenne | * | BLG/Gent | Laboratorium voor Kernfysica<br>Proeftuinstraat 86<br>B-9000 GENT, Belgium |
| 8. P. De Gelder | * | BLG/Gent | Laboratorium voor Kernfysica |
| 9. P.M. Endt | * | NED/Utrecht | Fysisch Laboratorium R.U.<br>Princetonplein 5<br>3508 TA Utrecht, The Netherlands |
| 10. P.D. Forsyth | * | UK/Liverpool | Oliver Lodge Laboratory<br>University of Liverpool<br>Liverpool L69 3BX, U.K. |
| 11. F. Kearns | * | UK/Liverpool | Oliver Lodge Laboratory |

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| 12. B. Erlandsson | * | SWD/Lund | University of Lund<br>Institute of Physics<br>Sölvegatan 14<br>S-223 62 Lund, Sweden |
| 13. J.A. Kuehner | * | CAN/TAL | Tandem Accelerator Laboratory<br>McMaster University<br>Hamilton, Ontario L8S 4K1, Canada |
| 14. M. Lederer | * | US/LBL | Lawrence Berkeley Laboratory<br>Bldg. 70A<br>Berkeley, California 94720, USA |
| 15. M. Martin | * | US/NDP | Nuclear Data Project<br>Oak Ridge National Laboratory<br>P.O. Box X<br>Oak Ridge, Tennessee 37830, USA |
| 16. S. Pearlstein | * | US/NNDC | Bldg. 197D<br>National Nuclear Data Centre<br>Brookhaven National Laboratory<br>Upton, New York 11973, USA |
| 17. B. Singh | * | KUW/ISR | Physics Department<br>Kuwait University<br>P.O. Box 5969<br>KUWAIT, Kuwait |
| 18. J. Tepel | * | FRG/FIZ | Fachinformationszentrum Energie, Physik, Mathematik GmbH<br>Kernforschungszentrum<br>D-7514 EGGENSTEIN-Leopoldshafen |
| 19. N. Tubbs | | NEA/DB | NEA Data Bank<br>B.P. 9<br>Batiment 45<br>F-91190 Gif-sur-Yvette, France |
| 20. P. Twin | * | UK/Liverpool | Oliver Lodge Laboratory<br>University of Liverpool<br>Liverpool L69 3BX, U.K. |
| 21. C. van der Leun (Chairman) | * | NED/Utrecht | Fysisch Laboratorium R.U.<br>Princetonplein 5<br>3508 TA Utrecht, The Netherlands |
| 22. A. Lorenz (Scientific Secretary) | | | IAEA/NDS |
| 23. J.J. Schmidt (Chairman) | | | IAEA/NDS |

Appendix 2

## Adopted Agenda

Opening of the Meeting: Monday 21 April, 09:30 - 10:00

- Opening Statements
- Election of Chairmen
- Adoption of Agenda
- Announcements

Morning Sessions: Monday through Friday from 9:00 to 12:30 with 30 minutes coffee break at 10:30. See Annex A to this Appendix for the Adopted Agenda. The morning sessions were chaired by J.J. Schmidt.

Afternoon Sessions: Monday through Thursday from 14:00 (2 PM) to 17:30 (5:30 PM) with 30 minutes coffee break at 15:30 (3:30 PM). The Agenda for the afternoon sessions is given in Annex B to this Agenda. The afternoon discussions were chaired by C. van der Leun.

Concluding Session: Friday 25 April, 14:00 (2 PM)
(chaired by the morning Chairman)

1. Other topics and unfinished business
2. Summary of actions and recommendations
3. Next meeting

## Adopted Agenda for Morning Sessions

1. Review of Actions and Recommendations from last meeting
2. Status reports from NSDD network members
3. Report on the status of NSDD network
4. Current mass-chain evaluation status
5. Mass-chain assignments
   a. New Groups
   b. Manpower commitment
   c. Current mass-chain assignments
   d. Network membership
6. Re-examination of evaluation procedure
   a. Mechanics of evaluation
   b. Review procedures
   c. Procedures to assure a four-year cycle
7. Publication of NSDD
   a. Nuclear Data Sheets
   b. Wall Chart of Nuclides
   c. Radioactivity Handbook
   d. Compilation of evaluations
   e. Horizontal compilations
8. Status of the Nuclear Structure Reference File
   a. Description of the NSR File
   b. Distribution of the NSR File
   c. Purging of the NSR File
9. Status of ENSDF
   a. ENSDF system
   b. ENSDF distribution
   c. ENSDF "working" file
10. Status of NSDD computer programmes
11. NSD Data Centre Services

Appendix 2, Annex B

## Adopted Agenda for Afternoon Sessions

1. Terminology

   a. Compilation, review, evaluation [1,2]

   b. Recommended NSDD definitions, notation, symbols, abbreviations

2. Nuclear and Decay Properties (treatment and systematics)

   a. Nuclear moments and directly measured spins

   b. Arguments for spin and parity assignments

   c. Lifetimes

   d. Log ft values

   e. Isospin

   f. Gamma-ray branchings

   g. Gamma-ray energies, excitation energies

   h. Resonances

3. Philosophy

   a. Presentation - reaction oriented vs property oriented
      - drawings and tables
      - traceability of data and evaluators arguments

   b. Uncertainties

   c. Mistakes

   d. "Standard reference values"

   e. "Minimum standards" for evaluators

   f. Use of unpublished data in evaluations

Appendix 3

## List of Papers Submitted to the Meeting

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|---|---|
| AG-258/1 | General Remarks on Format and Presentation of Nuclear Data Sheets (NDS). P.M. Endt (Appendix 23) |
| AG-258/2 | Comments on Endt's "General Remarks on Format and Presentation of Nuclear Data Sheets". W.B. Ewbank (Appendix 24) |
| AG-258/3 | Status Report on Japanese Activities in Nuclear Structure and Decay Data. T. Tamura (Appendix 15) |
| AG-258/4 | Structure and Contents of the Future Nuclear Structure Reference File. C.L. Dunford (Appendix 18) |
| AG-258/5 | Reference Guidelines for ENSDF (included in text) |
| AG-258/6 | Procedures for Assuring a Four-Year Cycle (included in text) |
| AG-258/7 | Status Report - Nuclear Structure Data Evaluation in Sweden. B. Erlandsson (Appendix 8) |
| AG-258/8 | Results from a Questionnaire about the use of "Table of Isotopes" and "Nuclear Data Sheets" circulated among Swedish Nuclear Physicists. B. Erlandsson (Appendix 8) |
| AG-258/9 | Statement on CBNM Activity in Evaluation and Compilation. W. Bambynek (Appendix 9) |
| AG-258/10 | Memorandum - Policies for Quotation of Nuclear Moments and Spins. V.S. Shirley and C.M. Lederer (Appendix 25) |
| AG-258/11 | Radioactivity Handbook. J. Dairiki (Appendix 16) |
| AG-258/12 | US Position on International Cooperation in the Area of Nuclear Structure Data (Appendix 13) |
| AG-258/13 | Notes relating to the transfer of ORNL Nuclear Data Project (NDP) responsibilities to the BNL National Nuclear Data Centre (NNDC) (included in text except for page G.1 which is given as Appendix 22 ) |
| AG-258/14 | Status of A-Chains (as of 3/80) (Retracted) |
| AG-258/15 | Nuclear Decay Data: The Statement of Uncertainties, W.B. Mann (ICRM) (Appendix 29) |
| AG-258/16 | Preliminary Results from the Radioactivity Handbook Survey. J. Dairiki (Appendix 17) |
| AG-258/17 | ENSDF-Data on microfiche (not included in Report) |
| AG-258/18 | Proposals on ENSDF (Appendix 20) |

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| AG-258/19 | Retrieval from ENSDF: INKARET System. J.W. Tepel and P. Luksch (Appendix 21) |
| AG-258/20 | Systematics of LOG FT Values in β-Decay. H. Behrens, P. Luksch, H.W. Mueller, J.W. Tepel (Appendix 26) |
| AG-258/21 | Note on the Calculation of Adopted Relative Gamma Branchings. J.W. Tepel (Appendix 28) |
| AG-258/22 | Status Report from FIZ. H. Behrens and J.W. Tepel (Appendix 7) |
| AG-258/23 | Radioactivity Handbook Survey Form. J. Dairiki (not included in report, see AG-258/16) |
| AG-258/24 | Role of "Physics" Interpretation in the A-Chain Evaluation Process, C.W. Reich (Appendix 30) |
| AG-258/25 | Symbols and Abbreviations from Nuclear Data Sheets (not included in report, see last page of Nuclear Data Sheets) |
| AG-258/26 | Activities Relating to the Evaluation of Nuclear Structure and Decay Data carried out by the Centre for Atomic and Nuclear Data. G.M. Zhuravleva and F.E. Chukreev (Appendix 6) |
| AG-258/27 | Status Report. P.M. Endt and C. van der Leun (Appendix 5) |
| AG-258/28 | Status of the Working File (included in text) |
| AG-258/29 | Status Report of the Franco-Belgian Group. J. Blachot (Appendix 11) |
| AG-258/30 | Gamma-Ray Standards - Excerpt from INDC-30/L+Sp (Retracted) |
| AG-258/31 | Status Report on Nuclear Structure and Decay Data Evaluation Project in Kuwait. B. Singh (Appendix 14) |
| AG-258/32 | NEA Data Bank Customer Service from the Evaluated Nuclear Structure Data File (ENSDF) (Appendix 10) |
| AG-258/33 | Status Report. P.J. Twin, University of Liverpool (Appendix 12) |
| AG-258/34 | Arguments for Isobaric Spin Assignments in Light Nuclei. P.M. Endt and C. van der Leun (Appendix 27) |
| AG-258/35 | Proposal for the NSDD Network Meeting - A Reference File for ENSDF (Appendix 19) |
| AG-258/36 | Summary of Bases for Spin and Parity Assignments - 1979 (Not included in report, see Nuclear Data Sheets) |
| AG-258/37 | Bases for Spin and Parity Assignments. P.M. Endt and C. van der Leun. (Not included in report, see Nuclear Physics A310(1978)5). |

Appendix 4

## List of Actions

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| 1. | van der Leun | Distribute to the network preprints of a horizontal compilation of gamma-ray energy calibration standards. |
| 2. | IAEA/NDS | Send to Erlandsson supporting evidence of the international effort in NSDD evaluation. |
| 3. | Network | Send results of questionnaire surveys of the use and usefullness of published evaluated NSDD (e.g. Evaluations in Nuclear Data Sheets and Nuclear Physics). |
| 4. | Network | Distribute to the network any documents or reports which substantiate the use and usefullness of NSDD evaluations. |
| 5. | Lederer | Include in the next moments compilation adopted values, with uncertainties, for all moments. Include higher moments, and the numeric values for correction factors applied to the experimental values. Consider also the inclusion of directly measured spins. |
| 6. | Network | Consider new additions, changes and deletions of $J^{\pi}$ assignment rules and send them to M. Martin (US/NDP), so that they can be used as a basis for discussion at the next meeting. |
| 7. | Network | Investigate if there are any appropriate groups interested to participate in the mass-chain evaluation effort; in particular of mass-chains 45-64 and 163-166. |
| 8. | USSR/CAJaD | Distribute to the network the book on "Characteristics of Radiation from Radioactive Nuclides used in the National Economy" by Yu.V. Kholnov et al, when it is published. |
| 9. | US/NNDC | Send to the Network all changes in the text of "Evaluation Review Procedures" and the "Normal Procedures for mass-chain Evaluation" (see AG-258/13) resulting from the responsibilities transfer from US/NDP to US/NNDC. |
| 10. | Network | Inform the Editor of Nuclear Data Sheets of the names of potential referees. |
| 11. | Behrens | Communicate to IAEA/NDS the IUPAP list of terminology and definitions. |
| 12. | IAEA/NDS | Distribute to the Network the IUPAP list of terminology and definitions for consideration at next meeting. |
| 13. | Martin | Prepare a list of common $\delta$ sign conventions, symbols and abbreviations and send it to van der Leun. |

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| 14. van der Leun | Prepare combined list of symbols, abbreviations and $\delta$ sign conventions, and distribute it to the network for consideration at next meeting. |
| 15. Endt | Write a note on spectroscopic factors for single nucleon transfer and distribute it to the network. |
| 16. Endt and van der Leun | Reformulate arguments on isospin assignments incorporating suggested changes, and circulate them to the network for discussion at next meeting. |
| 17. Endt | Consider the possibility of reviewing gamma-ray transition strengths in A>90 nuclei. |
| 18. Chukreev | Inform the network on the status of the USSR chart of the nuclides effort, and on the planned publication of the USSR wall chart of nuclides. |
| 19. Network | Complete the survey questionnaire regarding the future Radioactivity Handbook and return it to J. Dairiki not later than by the end of May. |
| 20. Pearlstein | Distribute to the network the report "Systematics of High Spin States" (BNL-26595). |
| 21. Network | Send to Lorenz, before end of May 1980, detailed information on planned, on-going and completed (since 1977 meeting) horizontal compilations. |
| 22. Pearlstein, Behrens and Lorenz | Send (on requests and if feasible) to other publishers of "Compilations of Evaluations", the internal file of their respective compilations of evaluations. |
| 23. Network (Standing action 1980) | Communicate to US/NNDC and US/NDP identified errors in the keywords in "Recent References". |
| 24. NSDD Evaluators (Standing action 1980) | Help clean up the NSR file in the process of evaluation, by informing US/NNDC of the identified errors. |
| 25. US/NNDC | Inform the network when the Hager-Seltzer Tables will be replaced in the HSICC programme by new conversion coefficient tables. |
| 26. Network | Send to M. Martin any suggestions for additional "minimum standards" to be used as guidelines by evaluators. |
| 27. Network (Standing action 1980) | Keep the Nuclear Data Sheet list of Symbols and Abbreviations under constant review, and send suggestions for changes to US/NDP. |
| 28. US/NDP and US/NNDC | Organize, in cooperation with FRG/FIZ, UK/Liverpool and FR/Grenoble, the feeding of mass-chain data in the A=5-44 mass-chain range into the ENSDF file. |

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| 29. | NSDD Evaluators | Communicate identified mistakes in the ENSDF file pertinent to the mass-chain for which they are responsible to US/NNDC and US/NDP for all mass-chains, and in addition to NED/Utrecht for mass-chains 21-44, and to US/UP for mass-chains 5-20. |
| 30. | Pearlstein | Ask Dr. K. Way if the mass-chain evaluation responsibility table, together with a note to authors of horizontal evaluations could be published in ADNDT. |
| 31. | Tepel | Write a proposal for entering delayed particle emission data into ENSDF, and distribute it to the network. |
| 32. | ENSDF Distributors | Send to all ENSDF requestors "Reference Guidelines for ENSDF". |
| 33. | Martin | Send to Chukreev a copy of the ADNDT article on LOGFT describing method used to calculate LOGFT. |
| 34. | US/NNDC | Distribute to the network specifications for the physics and format checking programmes. |
| 35. | Network | Send comments and suggestions to US/NNDC on the specifications of both checking programmes. |
| 36. | Bambynek | Distribute to the network copy of report from the June 1980 meeting of the International Commission of Radionuclide Metrology (ICRM) Subgroup on non-neutron nuclear data. |
| 37. | Martin | Make available to the network the US/NDP MEDLIST output from ENSDF. |
| 38. | Network (Standing Action 1977) | Send copies of all relevant NSDD network correspondence to IAEA/NDS. |
| 39. | NSDD Centres (Standing Action 1977) | Distribute on a regular basis those computer codes which could be useful to other members of the network. |
| 40. | US/NNDC (Standing Action 1977) | Communicate to the network all errors discovered in the ENSDF file and all changes made to the ENSDF file. |
| 41. | NSDD Evaluators (Standing Action 1977) | Follow general guidelines for mass-chain evaluation as stated in AG-105/24, AG-105/28 and AG-105/29 included in INDC(NDS)-92. |

Appendix 5

## STATUS REPORT UTRECHT

(P.M. Endt, C. van der Leun)

a. "Energy levels of A=21-44 nuclei (VI) has been published in

Nucl. Phys. A 310 (1978)1; errata, Nucl. Phys., to be published.

Preparations for the next edition, probably in 1983, are in progress.

b. Gamma-ray transition strengths

A < 45, published in ADNDT23 (1979)3; A=45-90 accepted for publication in ADNDT.

c. Gamma-ray energy calibration standards

A task-group of the IUPAP commission on Atomic Masses and Fundamental Constants/C. van der Leun, R.G. Helmer, P. Van Assche) has recommended a set of calibration standards. It has been discussed at AMCO6, and has been accepted for publication in ADNDT.

These reviews have been prepared without using computers.

L80-21530
Translated from Russian

# ACTIVITIES RELATING TO THE EVALUATION OF NUCLEAR STRUCTURE AND DECAY DATA CARRIED OUT BY THE CENTRE FOR ATOMIC AND NUCLEAR DATA (USSR STATE COMMITTEE ON THE UTILIZATION OF ATOMIC ENERGY)

G.M. Zhuravleva and F.E. Chukreev
Moscow, 1980

## 1. Development of activities relating to the evaluation of nuclear structure and decay data in the USSR

Since the last meeting of the Advisory Group on Nuclear Structure and Decay Data (Oak Ridge 1977), several scientists from the USSR State Committee on Standards have been involved in the work of evaluating nuclear structure data and have participated in data evaluation for the ENSDF file on masses 240, 242 and 244; the data have now been transmitted to the network of co-operating Centres and Groups. In addition, the Atomizdat Press [1] is at present publishing a manual by Yu.V. Khol'nov and co-workers entitled "Characteristics of Radiation from Radioactive Nuclides used in the National Economy: Evaluated Data", and it is this to which we should like to draw the participants' attention.

The manual presents tables of recommended values for the twenty most important nuclear-physics characteristics of 100 radioisotopes used in the national economy. These values have been derived on the basis of experimental data published in world-wide physics literature up to January 1979.

Each recommended value entails an error representing a 68%, and in some cases a 95%, confidence interval. The methods used to obtain the data and the principal references are indicated.

The tables of recommended values are accompanied by a description of the methods used for the critical analysis and selection of experimental data and the procedure for their treatment on the basis of the rules of mathematical statistics.

The establishment in the USSR of the State Service for Standard Reference Data [2] has provided a strong incentive for activities relating to evaluation of data in our country, including nuclear data.

2. Responsibilities of the Centre for Atomic and Nuclear Data for the ENSDF

As we know, the Centre for Atomic and Nuclear Data, and the Data Centre of the Leningrad Institute of Nuclear Physics associated with it, have been assigned the responsibility for the timely evaluation of the structural properties and data on the decay of three groups of nuclei. These are nuclei with masses 1-4, 130-135, 238, 240, 242 and 244. How are these responsibilities being discharged?

We have transmitted the following evaluations to the United States National Nuclear Data Centre:

1. A = 242, sent on 27 April 1978
2. A = 3, sent on 12 July 1978
3. A = 244, sent on 18 May 1979
4. A = 1, 3 and 240, sent on 6 February 1980
5. A = 134, sent in July 1979

During 1980, the evaluations for A = 238, 2 and 4 will be completed.

As regards the evaluations for A = 3 and 240, we should like to discuss with the participants several problems that may require a revision of the decisions taken at the 1977 meeting. The point is that in the case of mass 3, we transmitted the second evaluation a year and a half after the first one. The reason for this was that our calculations [3] revealed a noticeable effect by the chemical surrounding the tritium nucleus on its half-life. We felt it necessary to include these data in the ENSDF, but this does not mean that we are suggesting republication of this evaluation. In our opinion, the rules determining collaboration should be supplemented by a further one: "The Group or Centre, within its sphere of responsibility, may refine evaluated data before the expiry of a period of four years, if it is considered that new experimental data should be included in the ENSDF. These refined data should be disseminated in the form of magnetic tape recordings. Whether or not it is necessary to publish them ahead of time is to be decided by the editor of the 'Nuclear Data Sheets'". A rule of this kind would enable us to feed important new data into the ENSDF with greater efficiency.

The reverse situation was encountered by us during preparation of the evaluation for A = 240. Since the last issue of the Nuclear Data Sheets [4] very few new experimental data have been published and what is available does not in practice alter the results in Ref. [4]. Under these conditions we do not think that a new issue is essential, although we do feel it necessary to disseminate the 1980 version in the form of magnetic tape recordings.

3. "Adopted gammas" section

Several methods have now been developed for the calculation of nuclear reaction cross-sections using a large number of data on nuclear structure. One such method is the well-known GNASH program [5] developed in the USA. But programs of this kind, which give fairly good results (examples of agreement between calculated and experimental values will be found in Ref. [5]), require for their operation about 2000 punched cards with additional data about half of which are data on nuclear structure. All structural data needed by GNASH and similar programs are contained in the ENSDF but are located in different parts of it. What in fact these programs need are "adopted gammas" sections, i.e. expansion of the "adopted levels" section. Although formally, such a heading does exist, the ENSDF has in practice no such sections. In my view, the problems of calculating nuclear reaction cross-sections by methods like GNASH will, during the next few years, call for greater attention to "adopted gammas" sections on the part of the co-operating Centres and Groups.

REFERENCES

[1] Atomizdat, Annotated Subject-Oriented Publication Programme for 1980, Moscow (1979) (in Russian).

[2] Informatsionnyj Byulleten' GSSSD 6 (1978) 3.

[3] TIKHONOV, V.N., CHUKREEV, F.E., Report IAEh - 3102, Moscow (1979) (in Russian).

[4] Nuclear Data Sheets, 20, 218, 1977.

[5] YOUNG, P.G., ARTHUR, E.D., LA-6947, November 1977.

Appendix 7

STATUS REPORT

FACHINFORMATIONSZENTRUM ENERGIE, PHYSIK, MATHEMATIK GMBH

KARLSRUHE

FEDERAL REPUBLIC OF GERMANY

H. Behrens and J.W. Tepel

## 1. Participation in the Nuclear Structure Data Cooperation

The Fachinformationszentrum Energie, Physik, Mathematik has contributed to the international effort in nuclear structure data compilation by evaluating the mass chains

$$A = 84, 85, 86, 87, 91, \text{ and } 92.$$

Three of these mass chains have been published in Nuclear Data Sheets, whereas A = 85, 91 and 92 have passed the review procedure and are in press. Three further chains, viz. A = 93, 95, and 96 are in preparation at the present time. Until the end of 198o we expect to have completed these three chains as well as A = 94 and 97.

The Oak Ridge program package consisting of retrieval and display programs in PL/I on the one hand and analysis programs in a FORTRAN/ASSEMBLER mixture on the other was implemented on our Siemens Computer installation. Fully operational are the programs START 44, SAVE 44, and FETCH 44 used for storing and retrieving data sets from the ENSDF data bank, whereas the NDSLIST program, which is used for producing Nuclear Data Sheets-like output from the coded data sets, is functioning without plotting capabilities. Results from NDSLIST are printed on a special printer chain.

The analysis programs HSICC, GTOL, LOGFT, and MEDLIST are fully operational as an ASSEMBLER/FORTRAN mixture. The FORTRAN programme ANGCOR is used as supplied by the Brookhaven National Laboratory. In addition further analysis programs in PL/I were received from Oak Ridge, viz. DATACK, TRANLOC, COMPARE, ADOPFIT and GBRANCH, of which only the first one is extensively used, although all are functioning on our installation.

## 2. Program development:INKARET

In addition to and supplementing the above program package, retrieval, display and analysis programs were developed locally.

In order to improve the retrieval capabilities from ENSDF the original data file was reconstructed as an ISAM file using a special 16-digit key. This key was designed in such a manner, that the original sequence of data records in ENSDF is preserved in the new file, enabling the use of all ENSDF-programs. However, in contrast to the old system, where retrieval was purely data setwise, direct retrieval of individual records is now possible. More details about this system are given in an appendix. The modified system (INKARET) is particularly useful for horizontal compilations where specific properties are selected from the file for many different nucleides. As an application a systematic study of log ft-values in beta decay was undertaken (see appendix). Programs involved in data manipulations from the new file are. BNLTRANS, AZTAB, ISAGEN, RET.SAVE, RET.SAVE, RET.DSET, RET.ALL, and RET.BETA.

Analysis programs developed at Karlsruhe include ADINF, NORMGA, GSORT and PROLEV. The first program aids in the construction of ADOPTED LEVELS, GAMMAS by comparing results from many data sets in a compact manner. NORMGA normalizes gamma intensities for any one particular gamma data set, whereas GSORT and PROLEV help to place gammas in level schemes and suggest possible new levels.

## 3. The Nuclear Structure References File (NSR)

The set of NSR-tapes spanning the years 191o-1978 and the 1979 update tape were merged into a single tape file. With the aid of a series of computer programs developed by our group in Karlsruhe, the NSR documents were stored on direct access devices as an ISAM-file. Concepts appearing in the SORTSELS-field (see W.B. Ewbank - The Nuclear Structure References (NSR) File, ORNL 5397) were used to construct inverted lists. The NKEYWRDS and NTITLE fields were scanned for the presence of fixed descriptors, which were also entered in the inverted list. Retrieval from this file is by means of logical combinations of descriptors, e.g. FIND 86SR and T1/2 and COULOMB EXCITATION. This file is a source of literature for mass chain evaluations as well as for answering queries from the nuclear physics community. The programs involved with NSR are VLENGTH, RRINV1, RRIN V1, SEARCH,RRDIS.2.

## 4. Information from ENSDF

We have received several requests for data from ENSDF. These included files of all adopted levels on tape as well as information on alpha decay properties of certain nuclei. Since several users were interested in the radioactive decay of all unstable nuclei, involving extensive calculations with the MEDLIST program, we constructed a data file consisting of MEDLIST-results, ordered according to the A- and Z-values of the parent nuclei. This MEDGEN data bank is regularly updated with MEDLIST-calculations on new data sets from ENSDF.

## 5. Bibliography of existing Data Compilations

A bibliography is published by us at regular intervals. This publication gives a worldwide survey of all existing physics data compilations. The following issues have been published up to date:

3-1 (1976): Datensammlungen in der Physik./Data Compilations in Physics.
H. Behrens and G. Ebel. 226 pages.
A bibliography of about 145o existing tables and compialtions from all the fields of physics.

3-2 (1977): Datensammlungen in der Physik./Data Compilations in Physics.
H. Behrens and G. Ebel. 116 pages
Supplement to No. 3-1 containing about 55o further references to tables and compilations.

3-3 (1978): Datensammlungen in der Physik./Data Compilations in Physics.
H. Behrens and G. Ebel. 78 pages.
Supplement to No. 3-1 and 3-2 containing about 35o further references to tables and compilations.

3-4 (1979): Datensammlungen in der Physik./Data Compilations in Physics.
H. Behrens and G. Ebel. 86 pages.
Supplement to No. 3-1, 3-2 and 3-3 containing about 42o further references to tables and compilations.

## 6. Horizontal Compilations and Evaluations

One of the major objectives of the Fachinformationszentrum is to issue data compilations (and evaluations) for certain subfields of physics. A number of the items already published are also of relevance to nuclear physics. These compilations are always published in the series "Physics Data".

STATUS REPORT

NUCLEAR STRUCTURE DATA EVALUATION IN SWEDEN

B. Erlandsson

During the two and a half years since the last meeting of the advisory group at Oak Ridge we in Lund have been working with A = 113, a chain which has not been revised since 1970. The compilation group consists of B. Erlandsson, J. Lyttkens and K. Nilson and about one man-year has been put into this project. In spite of our limited resources the compilation work has been possible thanks to a close cooperation with the group at the University of Liverpool, and we hope to send our first version of A = 113 to Oak Ridge during the summer.

We have now for several years tried to raise some funds for the continuation of the compilation activity but in vain and if the situation has not changed before the work with this mass chain is completed, we will be forced to withdraw from the compilation collaboration, which we very much regret.

Results from a questionaire about the use of "Table of Isotopes" and "Nuclear Data Sheets" circulated among swedish nuclear physicists.

This investigation was performed during the months of March and April 1980, and the questionaire was distributed to people employed in nuclear physics at universities and research institutes in Sweden.
The aim of the questionaire was to get an idea of how wideley used "Table of Isotopes" and "Nuclear Data Sheets" are and if it is possible to replace the printed form with a computer tape and also if people are satisfied with the two publications.
The estimated coverage was about 50%.
Here follows the questions which 58 persons have answered.

1. Do you have access to "Table of Isotopes" (ToI) and "Nuclear Data Sheets" (NDS) at your working place or institute.
   ToI Yes: 98% No: 2% NDS Yes: 93% No: 7%.

2. How often do you use ToI and NDS.

| | ToI | NDS |
|---|---|---|
| Once a week or more | 51% | 23% |
| Once a month | 40% | 51% |
| Once a year | 9% | 26% |

3. If you are looking for nuclear reaction data, do you use:

| | | |
|---|---|---|
| NDS | Yes: 93% | No: 7% |
| Other publications | Yes: 69% | No: 31% |

   Comments: 9 persons mentioned various publications
   27% had yes in both cases.

4. If you are looking for decay data, do you use:

| | | |
|---|---|---|
| ToI | Yes: 98% | No: 2% |
| NDS | Yes: 83% | No: 17% |
| Recent ref. in NDS | Yes: 78% | No: 22% |

   40% had yes in all three cases.

5. Do you want to have nuclear data stored on computer tape and in such a form that you can have a look at them on a computer terminal.
Yes: 59% No: 41%.

6. If so could this replace the printed form of ToI and NDS.
Yes: 16% No: 84%.

7. Are you satisfied with the present form of:
ToI Yes: 93% No: 7% NDS Yes: 87% No: 13%

General conclusions:
Most people involved with nuclear physics in Sweden have good access to both Table of Isotopes and Nuclear Data Sheets and they use them quite often. When they use them they look not only at one of them but at them both and also pay special attention to Recent references in NDS.
Computer based nuclear data is at present no real alternative, perhaps because of lack of access to computer terminals and even if the access should be greater the terminal can not replace the printed form.
People are on the whole satisfied with the present situation.

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CBNM/RN/17/80
Geel, 15.04.1980

## Statement on CBNM Activity in Evaluation and Compilation

W. Bambynek

1. Compilation of internal conversion data

A compilation of experimental results of internal conversion coefficients and their ratios for nuclides with $Z < 60$ has been finished [1]. Results quoted with an error and published later than November 1965 and prior to December 1978 have been included. Separate tables have been prepared for results from studies on radioactive nuclides, from nuclear reaction experiments, from measurements of E0 transitions, and from studies in various chemical environments. The tables include information on the origin of the isotope, transition energies, spin and parity of initial and final levels, experimental technique used, and literature references.

[1] H.H. Hansen, Compilation of experimental values of internal conversion coefficients and ratios for nuclei with $Z < 60$, Physik Daten/Physics Data 17-1 (1980) in press.

2. Evaluation of K-shell fluorescence yields

An evaluation of all K-shell fluorescence yields published later than 1972 is in progress. From these data and those included in the 1972 review [2] a list of recommended data for all atomic numbers will be produced. The new evaluation will be finished by the end of 1980.

[2] W. Bambynek, B. Crasemann, R.W. Fink, H.-U. Freund, Hans Mark, C.D. Swift, R.E. Price, P. Venugopala Rao, X-ray fluorescence yields, Auger, and Coster-Kronig transition probabilities, Rev. Mod. Phys. 44, 716 (1972), 46, 853 (1974).

3. Critical survey of data sources

A survey of the most important compilations and evaluations in the nuclear field is in progress in collaboration with the FIZ, Karlsruhe, the Institut für Kernenergetik, Stuttgart and the Institut für Kernchemie, Darmstadt. CBNM is responsable for the data sources on nuclear decay and on radioactivity.

4. Recommended list of transactinium isotope decay data

CBNM collaborated in a critical appraisal of the current status of transactinium isotope half-lives and branching fractions which were compiled by members of the IAEA Coordinated Research Programme on the Measurement and Evaluation of Transactinium Isotope Decay Data [3].

[3] A. Lorenz (ed.), INDC(NDS)-108/N (1979).

Appendix 10

## NEA Data Bank Customer Services from the EVALUATED NUCLEAR STRUCTURE DATA FILE (ENSDF)

N. Tubbs

### Introduction

The ENSDF file and the associated Nuclear Structure Reference (NSR) file were built up, and are currently still maintained, by the Oak Ridge-based Nuclear Data Project. Over the period 1980-1981, responsibility for the maintenance of these files, together with service work in support of the international NSDD evaluation effort is gradually being transferred to the National Nuclear Data Centre (NNDC, Brookhaven).

NEA Data Bank regularly receives copies of the ENSDF file from NNDC, and in order to help the French and Belgian NSDD evaluation groups co-ordinated by Dr. Blachot of CEN Grenoble, and as part of a general program to improve customer service from the Data Bank, these data and the corresponding search and output formatting programs have been stored on a NEA-DB private disk held at the CISI Saclay computing installation.

By using standard procedures filed at CISI, any user linked to the Saclay IBM 3033 computer through the CISI network in France, Belgium and the United Kingdom can have access to the data by executing the search and formatting programs stored on the same disk. The Data Bank will of course carry out retrievals and send output by post to customers in its service area not linked directly to CISI, though users in the Federal Republic of Germany should address their requests to Fachinformationszentrum Energie und Mathematik in Karlsruhe.

### Retrieval and listing programs implemented by NEA-DB

The three programs FETCH, NDSLIST and MEDLIST, in the August 1978 version supplied by the Nuclear Data Project, have been implemented on the IBM 3033 computer at the Saclay site of the Compagnie Internationale de Services en Informatique (CISI), together with the ENSDF file :

FETCH44 retrieves data sets from the ENSDF file via the indexed sequential DBINDEX as specified by combinations of values or ranges of different keywords, and supplemented by up to five character strings which should also appear in the index record. The output can be 'filtered' to restrict the energy levels to be included in output.

NDSLIST is used to produce standard format tables of energy levels, radiations, etc., for data sets retrieved by FETCH44 from the master files. The format is that of the Nuclear Data Sheets.

MEDLIST calculates and prints out X-ray, $\beta$ and $\gamma$ intensities and radiations as well as the dose (useful for medical applications).

It is hoped at a later stage, and following their installation on an integrated data base at NNDC, to offer a retrieval service on Nuclear Structure References.

Search and output from the ENSDF file on the IBM 3033

In order to simplify remote access to ENSDF data on the CISI installation, and to avoid the need to inform users individually of changes in the Job Control information required to search and print the file, this information has been grouped in the "public" procedures FETCH, NDSLIST and MEDLIST. Execution of these jobs is thus extremely simple and output can appear directly on the user's terminal.

A typical search and printout job would require the following input from the user :

(1) JOB CONTROL using named procedures FETCH, etc.,

```
/*JOB=FIND07,ACCT=(*********,LUIGI****),XEQ=E33,ALL=OCD
// JOB MSGLEVEL=(2,1),TIME=1
/*JESPARM PROCDSN=NEADB@.PROC.CNTL,EXCP=10,SYSOUT=1000
/*UNIT 3330,1
// EXEC FETCH
// EXEC NDSLIST
// EXEC MEDLIST
```

(2) DATA CARD defining search parameters

```
FETCH     Z=96 A=242
```

However it is only fair to warn potential users that one important problem remaining is the limitations of the character sets implemented on the user's installation or at CISI itself. The Nuclear Data Sheets publication is produced using the program NDSLIST and a very much extended special character set; output from almost any other system will inevitably suffer from missing characters or arbitrary substititions affecting in particular Greek characters, subscripts and superscripts, as well as (on some printers) lower case characters. With the aid of his imagination and a copy of Nuclear Data Sheets, a physicist should not find difficulty in completing the taps which occur in column headings. The computing time used in making direct retrievals on the IBM 3033 will be charged by CISI to the user.

Documentation

A note on this service, with examples of user queries and ENSDF output, is available from NEA Data bank. Users in the US and Canada should write to NNDC, and in FR Germany to FIZ Karlsruhe.

Appendix 11

# STATUS REPORT
## FRENCH, BELGIAN GROUP

J. Blachot

## A. FRENCH GROUP -

### 1. Participation in the Nuclear Structure Decay Data Network -

The French group has started its contribution to the International Network in collaboration with NDP Oak Ridge. This group is formed by 2 physicists in Orsay (J. Oms, J.P. Husson), 1 in Lyon (G. Marguier), 1 in Strasbourg (F. Haas) and 1 in Grenoble (J. Blachot), coordinator.

### 2. Computer -

The analysis programs HSICC, GTOL, LOGFT, MEDLIST are fully operational as an assembler Fortran, on the IBM of Saclay (CISI). ADINF, NORMGA (from Karlsruhe) are also running.

The Oak Ridge package of PL/1 programs, FETCH, SAVE, START, NDSLIST, are also fully operational on the CISI computer (see the NEA Data Bank paper).

### 3. Mass chain evaluation -

A = 116 is in the review procedure
A = 114 will be finished in June 80
A = 104 will be finished in December 80

### 4. Radioactivity Data -

The CEA has developed a Radioactivity file mainly from ENSDF. The Fission products parts have been published in Atomic and Nuclear Data Table (ADNDT 20). The complete file is available on magnetic tape (> 2000 isotopes).

## B. BELGIAN GROUP - Opening Statement -

E. Jacobs, P. De Gelder, D. De Frenne, Nuclear Physics Laboratory, Ghent, Belgium.

We are interested in participati ng in the mass-chain compilation and evaluation work in the framework of the responsibilities of the French group, as proposed by Dr. J. Blachot, Grenoble. We started our activities with mass-chain A = 102, which will probably be completed before the end of the year. Recently, the programs HSICC, GTOL and LOGFT were adapted to our WAX11-system (DEC) and are now fully used to analyze the ENSDF.

# STATUS REPORT

P.J. Twin (University of Liverpool)

The United Kingdom were allocated the long-term responsibility for A=65-80 at the Advisory Group Meeting at Vienna in May 1976.

## 1. Personnel

The U.K. Science Research Council have funded, since January 1977, one post primarily but not entirely for data evaluation work. Dr. F. Kearns has held this post and he has been assisted by two other scientists, Dr. J.N. Mo (from January 1977) and Dr. L.P. Ekström (from July 1978), both of whom work part-time on evaluation activities.

## 2. Mass-Chain Schedule

### 2.1. Completed mass-chains

A=70 was submitted January 1978
A=71 was submitted September 1978
A=73 was submitted September 1979
A=72 was submitted December 1979

### 2.2. Mass-chains being reviewed at present

A=75, submission planned for summer 1980
A=68, submission planned for summer 1980
A=67, submission planned for end of 1980

Dr. Ekström is also assisting the Swedish group with their mass-chain evaluation work.

## 3. Computer Programmes

### 3.1. Nuclear Structure Data File

Copies of the File and associated programmes (START44, FETCH44, SAVE44, HSICC, GTOL, LOGFT, DATACHECK, TRANLOG, ANGCOR and COMPARE) were obtained from Oak Ridge and they have been running successfully on the 370/165 computer at Daresbury.

A programme has been written to enable users to access the Data File interactively from a terminal via TSO. This system is now available from any of the many terminals at Universities connected to the SRC network in the U.K. At present this facility has not been widely publicised due to the incompleteness of the Data File. In a small field trial it was found that physicists requested information on their favorite nucleus and they often found that only an adopted levels data set existed. Their comment was "not as useful as the Nuclear Data Sheets" and hence was counter productive.

However some use is being made of the File by applied physicists from Harwell, CEGB, Glasgow University etc.

3.2. Evaluation Programme Development

Programme development has included DELTA, LEVELS, TRANS and changes to GTOL. DELTA replaces ANGCOR and it deals with $\gamma$-$\gamma$ angular correlations and, for example, enables more information to be included in the fitting procedure. LEVELS is used in ordering energy levels from all data sets and TRANS translates Liverpool condensed format to ENSDF format.

3.3. The Nuclear Structure Reference File

The Berkeley Data Base Management System has been installed at Daresbury and implemented with the Nuclear Structure Reference File.

## 4. Future Plans

4.1. Personnel

The two part-time evaluators are ceasing evaluation activity by the end of 1980 and Dr. Kearns will also relinquish the data evaluation post. However, the SRC has agreed to continue funding the Data Evaluation work and it is planned to recruit a new evaluator. Dr. P.D. Forsyth of Liverpool University is proposing to become involved in evaluation work and it is also hoped that other scientists will be found to carry out part-time evaluation work. It appears inevitable, though, that there will be a short term reduction in the level of U.K. evaluation activity.

4.2. Location of evaluation work

It is planned to move most of the evaluation work to Liverpool University whilst still making use of the computer and library services of the Daresbury Laboratory. The U.K. centre should be designated, in future, Liverpool rather than Daresbury.

4.3. U.K. allocation

The experience of our evaluators is that it takes longer than originally envisaged to complete a mass-chain. Factors which have affected this schedule include; distance from Oak Ridge, inclusion of adopted gammas, and the fact that none of our evaluators are full-time.

It is, therefore, requested that the U.K. allocation be reduced to about 8 mass-chains.

The present position is as follows: Of the original U.K. allocation of 16 mass-chains, 4 (A=77-80) were re-allocated to Kuwait and 7 (A=67, 68, 70, 71, 72, 73 and 75) have been or are being reviewed. It is planned to review at least two more mass-chains, probably A=69 and 74, by the end of 1981. The remaining mass-chains in the allocation are A=65, 66 and 76.

IAEA Advisory Group Meeting on
Nuclear Structure and Decay Data for Applications

Vienna, Austria

21-25 April 1980

# U.S. Position on International Cooperation in the Area of Nuclear Structure Data

## 1. Introduction

At the Advisory Group meeting in Vienna in May 1976, the opening U.S. statement emphasized the advantages of international cooperation in the compilation and evaluation of Nuclear Structure and Decay Data (NSDD) information. Eighteen months later in Oak Ridge, various centers around the world accepted responsibility for the evaluation of mass chains. This effort is extemely important to the world scientific community. The U.S. plays a major role in this effort but eagerly seeks the cooperation of centers accepting responsibility for mass chains. At this meeting, we can review the status of the last two and one half years effort by these centers in meeting their commitments.

This report will review the work of the Nuclear Data Network* (USNDN), the coordinated group of U.S. evaluation centers. This will include not only the evaluation work but also related activities of the USNDN members.

As a result of a change in ORNL program emphasis, the transfer of the publication, scanning, and service related activities from ORNL-NDP to the BNL-NNDC is now underway and is scheduled to be completed by summer 1981. Because of cooperation between NDP and NNDC, the US network expects no interuption in and eventual improvement of the services from the US.

Because of the changes in the U.S. laboratory resources and its program emphasis, the USNDN is looking to reassign responsibility for 48 mass chains from the list of their responsibilities previously accepted. The French-Belgian collaborating groups have agreed to accept responsibility for some of these mass chains. For the rest, the U.S. is still actively searching for new evaluation groups at laboratories and universitites in the U.S. and elsewhere.

With much of the administrative details having been discussed at previous meetings the U.S. welcomes the shift in priorities at this meeting as a much larger proportion of time will be spent discussing the physics questions involved in evaluation.

*USNDN is comprised of BNL-National Nuclear Data Center (NNDC), INEL-Nuclear Physics Branch, LBL-Isotopes Project, NBS-Photonuclear Data Center, ORNL-Nuclear Data Project (NDP), and U. Pennsylvania-Energy Levels of Light Nuclei.

## II. Publications

The present status and future plans of some publications produced by the U.S. that are of interest to the NSDD network are:

A. Wall Chart of Nuclides - Forty thousand copies were printed in early 1978. The U.S. intends to continue producing a wall chart with the next edition approximately two years after the Karlsruhe chart i.e., about the end of 1982.

B. Table of Isotopes - The seventh edition (1625 pages) was published at the end of 1978 by John Wiley and Sons. The Table of Nuclear Moments containing nuclear magnetic and quadrupole moments reported through early 1977 was published as an appendix in this seventh edition. This is the last edition of the Table of Isotopes (see Section F).

C. Nuclear Wallet Cards - Since they were published in 1979, 6500 copies of the 84 page "shirt pocket" booklet containing table of nuclear properties, elemental properties, fundamental constants and energy conversion factors have been distributed. The U.S. plans to continue publishing the wallet cards periodically deriving the nuclear properties from ENSDF.

D. Recent References - Since 1978, three issues per year of Recent References have been published with the third issue being cumulative for the whole year. The publication responsibility will shift from ORNL-NDP to BNL-NNDC October 1, 1980.

E. Nuclear Data Sheets - Of the 1979 publications, approximately one-third of the evaluations were performed by new centers i.e., by non-NDP evaluators. The publication responsibility will shift from ORNL-NDP to BNL-NNDC on or before July 1, 1981. BNL will provide services to network evaluators beginning January 1, 1981.

F. Radioactivity Handbook - The Table of Isotopes will no longer be produced. Instead, a handbook of nuclear data for applied users is in the planning stages. The frequency of publication will be consistent with the cycle time of ENSDF. Details will be provided later at this meeting.

## III. Primary Resource Files

A. Evaluation File (ENSDF)** - Since the last meeting five editions of the master file of evaluated data have been distributed to international data centers (and others upon request) in February 1978, August 1978, March 1979, August 1979 and most recently in March 1980. It is planned to continue to make the master file available at six month intervals.

B. Working File - The status and experience with this file of selected experimental values provided by the evaluators is to be discussed at this meeting. Several entries have been made by the U.S. evaluators. The maintenance and availability of this file will depend on the outcome of these discussions.

**ENSDF is an ORNL-NDP developed format accepted for international exchange of nuclear structure and decay data (NSDD) by the IAEA NSDD network.

III. Primary Resource Files (cont.)

C. Bibliographic File - Portions of this file dealing with pertinent mass chains are sent to the NSDD Network evaluators. In addition, the NSR file has been distributed in October 1978, October and November 1979, and February 1980. The cumulative supplement to the NSR file distributed in Nov. 1979 has just been received at BNL-NNDC and has been distributed.

## IV. Status Reports of the U.S. Nuclear Data Network

### A. BNL-National Nuclear Data Center

The mass chains A=112, 136, 140, 141, 142, 143, 144, and 145 have been published in Nuclear Data Sheets. In addition, A=139 has been completed and is under review. Work is in progress on A=138.

The ENSDF and NSR tapes provided by ORNL-NDP have been distributed to non-U.S. distribution centers and upon request to a number of other centers.

The physics analysis programs for evaluation of nuclear structure data documented in BNL-NCS-23375 are being maintained. Some errors pointed out by users in the NSDD network have been corrected. An updated version of the program tape is available upon request.

A second edition of a source list of nuclear data evaluations and bibliographies BNL-NCS-50702 has been published. It uses the American Institue of Physics' physics and astronomy classification scheme. Work on a Third edition is now underway.

The fourth edition of the bibliography of charged particle nuclear data BNL-NCS-50640 is in press. This is a cumulative edition of references from January 1, 1976 to March 15, 1980.

The resonance parameter handbook, BNL-325, is being revised. The evaluation of data for $21 \le Z < 60$ is complete and data on $Z \le 20$ is presently being evaluated. Part I, $Z \le 60$ will be published this year.

A retrieval system for Nuclear Structure References written in FORTRAN using Data base management system, DBMS-10, and a retrieval system for ENSDF have been completed.

### B. INEL - Nuclear Physics Branch

Mass chain A=159 has been published and A=158 has been completed and is under review. Work is in progress on A=153 and A=157.

The preparation of evaluated decay data sets for the Evaluated Nuclear Data File (ENDF/B-V) is nearly complete. For the Fission-Product file, 318 nuclides have been evaluated; for the Actinide file, 103 nuclides have been evaluated; and for the Activation file, 69 nuclides have been evaluated.

### C. LBL - Isotopes Project

Mass chain A=163 has been published and A=191 has been completed and is under review. Work is in progress on A=174, 188, 189, 190, 192, and 193.

## IV. Status Reports of the U.S. Nuclear Data Network

### C. LBL - Isotopes Project (cont.)

The seventh edition of the Table of Isotopes was published in 1978 with the Table of Nuclear Moments included as an appendix. A memo has been written to aid ENSDF evaluators in quoting moments and spins.

The Nuclear Wallet Cards were produced. The data presented in the nuclear properties table are adopted values from the Table of Isotopes (7th Edition).

The Table of Nuclides (an expanded version of the Nuclear Wallet Cards) was provided to E.S. Macias and G. Friedlander for inclusion in their forthcoming textbook "Nuclear and Radiochemistry" (3rd Edition).

A "Radioactivity Handbook" for applied users is being planned. The proposed contents and format will be presented later at this meeting. A Handbook sample and two page questionnaire have been sent to members of a number of professional societies asking for comments. Work has begun on computer programs for the production of the Handbook.

### D. NBS - Photonuclear Data Center

Supplement 1 to the NBS Special Publication 380, Photonuclear Reaction Data, 1973 has been published. It contains a complete annotated index to experimental data published and entered into the Center's files in the period from January 1973 through March 1978. It also contains an index to the cross section data available in the Center's digital data library.

An evaluation of the available photonuclear reaction data for $^{12}C$, $^{14}N$ and $^{16}O$ for excitation energies up to 30 MeV has been completed. The resulting annotated compilation presents a consistent set of cross section data in both graphical and tabular form for each nuclide. Also included are tables of energy-weighted moments of the various cross sections as well as bremsstrahlung weighted yields and radioactivity decay data for the residual nuclides produced by the various reactions. The compilation is currently undergoing internal review and should be ready for limited circulation in preprint form by April 1.

### E. ORNL - Nuclear Data Project

Since the last meeting, 42 mass chains have been published and 3 mass chains are under review. 16 mass chains are in progress.

The multiply indexed bibliography to nuclear structure references (NSR) has been maintained and services provided from the file to network evaluators. The file has been sent to BNL-NNDC for distribution to the NSDD network in 1978, 1979, and 1980. Updates to the file have been published in Nuclear Data Sheets three times per year with the third issue being cumulative for the whole year. In addition, a three-year cumulative of NSR was published in the Nuclear Data Sheets in 1978.

Complete magnetic tape copies of the permanent master file ENSDF have been prepared twice a year and sent to BNL-NNDC for distribution to the NSDD network.

E. ORNL - Nuclear Data Project (cont.)

The MEDLIST program has used ENSDF in deriving x-ray intensities to determine cross sections from radiation yield. Levels by half life were prepared from ENSDF for the INDC. An article on the activity from spontaneous fission isomers was published making use of ENSDF.

An evaluator training session was held at ORNL-NDP during November 1978 and at JAERI, Tokai-Mura, Japan during December 1979.

All mass chains have been reviewed since early 1978. ORNL-NDP is still reviewing the first few mass chains from new evaluators.

F. Univ. of Pennsylvania - Energy Levels of Light Nuclei

The mass chains A=18 through A=20, and A=5 through A=12 have been published in Nuclear Physics. Mass chains A=13, 14, and 15 will be sent to Nuclear Physics by September. Preprints of A=13, and A=14 are being sent out for review. Mass chains A=16 and 17 will be done in 1981. For these light nuclei, the total number of published papers per year is unchanged, although the ratio of theoretical to experimental papers is going up.

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Appendix 14

## STATUS REPORT ON NUCLEAR STRUCTURE AND DECAY DATA EVALUATION PROJECT IN KUWAIT

At the last meeting of the advisory group on Nuclear structure and decay data, in agreement with Daresbury group, the Kuwait team was assigned responsibility for evaluating mass chains A = 77 to 80.

Active work on this project was started in November, 1978, with the financial support from the Kuwait Institute for Scientific Research (KISR) and Kuwait University. The project is being carried out under the overall direction of Adnan Shihab-Eldin and Isam Naqib. B. Singh (assoc. research scientist with KISR since November 1978) attended evaluation orientation meeting at Oak Ridge in November, 1978. He devotes about 80% of his time to this project. D. Viggars (Physics Dept., Kuwait University) spends about 20% of his time on evaluation work.

Computing facilities are being provided by Kuwait Government Computer Centre which operates a dual CPU based on IBM-370 system. We use this facility through remote "CMS" terminals located at KISR as well as at the University. The interactive system using a large number of video terminals operates through a so called Conversational Monitor System (CMS). This system allows the user a very convenient and fast page editing capability. At the same time one avoids the need to handle a large number of computer cards. All the data analysis programs supplied by Oak Ridge and Brookhaven were functional by January 1979. For NDLIST and PLOT programs, we still depend upon the Oak Ridge facility.

The Science Library of Kuwait University subscribes to a large number of physics journals. The Oak Ridge NDP library has been very helpful in providing us with photocopies of laboratory reports and meeting abstracts. The National Scientific and Technological Information Centre (NSTIC) of KISR obtains for us theses and photocopies of articles from journals not available locally.

The first mass chain evaluation A = 77 was submitted to Oak Ridge, for review, in July, 1979. We learn that it is due to appear in the January, 1980 issue of Nuclear Data Sheets.

Work on mass chain A = 78 was started in July, 1979. Concurrently mass chain A = 188 is being completed. This was started during summer 1979 at Lawrence Berkeley Laboratory in collaboration with the Isotopes Project there. Preliminary manuscripts of both these mass chains were prepared in February, 1980 at Oak Ridge National Lab. Both these mass chains are now ready to be submitted for a review.

We have already initiated work on mass chain A = 80, which we hope to finish by September, 1980. It seems plausible that by January, 1981 we would have completed evaluation of A = 79, thus finishing the initial responsibility for mass chains A = 77-80.

April 21, 1980

Appendix 15

Status Report on Japanese Activities in Nuclear Structure and Decay Data

Tsutomu Tamura

Nuclear Data Center, Japan Atomic Energy Research Institute

Activities in Nuclear Structure and Decay Data have been mainly promoted by the Nuclear Structure Data Working Group of Japanese Nuclear Data Committee(JNDC) and is summarized as follows:

1. Evaluators --- manpower and training
At present, 9 experimental nuclear physicists have been cooperating in the mass-chain evaluation on the part-time basis. All these evaluators participated in the Orientation Seminar conducted by an ORNL staff held at Japan Atomic Energy Research Institute on 3-7 December, 1979.

2. Computer --- The ORNL ENSDF programs and their BNL version have been successfully operated on IBM 370 and partially on FACOM 230/75(JAERI in house) computers until March 1980. FACOM M-200, newly replaced in house JAERI computer, has begun utilized for all the evaluation work without the help of IBM 370.

3. Time schedule --- Mass-chain evaluation
Up to now, evaluation of 4 masses has been completed. Evaluation of 12 masses in 4 years as allotted for Japanese contribution in the 1977 NSDD meeting will be fulfilled according to the following schedule:

| | |
|---|---|
| A=121, 119* | July 1977 - Oct. 1978 |
| A=123, 125, 127 | Aug. 1978 - Oct. 1979 |
| - - - - - - - - | - - - - - - - - |
| A=126, 128, 129 | Aug. 1979 Aug. 1980 |
| A=120, 122, 124 | Aug. 1980 - Aug. 1981 |
| A=118, 119, 121 | Aug. 1981 - Aug. 1982 |

4. Compilation of Japanese References --- Due to the shortage of manpower in this activity, compilation of Japanese references has been delayed. A new group was assigned in April 1980, and will make the first contribution of the keyword-input data around May 1980.

5. Other NSDD activities in JNDC --- ENSDF data have been applied in the decay heat evaluation and revision of the Chart of Nuclides**. Revised edition of the Chart of Nuclides will be published around March 1981.
A meeting on the evaluation and application of NSDD was held on 10-11, December 1979.

* Evaluation of A=119 was made by ORNL center.

** Y. Yoshizawa, T. Horiguchi and M. Yamada: Chart of Nuclides, Feb. 1977 Japanese Nuclear Data Committee/Nuclear Data Center

# RADIOACTIVITY HANDBOOK

A *Radioactivity Handbook* for applied users is one of the planned publications of the U.S. Nuclear Data Network. On behalf of the NDN, the Isotopes Project at LBL will produce the *Handbook* with specifications agreeable to members of the international network of nuclear structure and decay data centers. We are requesting comments and suggestions from our colleagues on the contents and format proposed below.

The purpose of the *Handbook* is to provide a compilation of recommended decay data, based on the ENSDF file, that is detailed enough for use in sophisticated applications, but that is organized clearly so as to be usable in routine applications. The *Handbook* is not intended as a nuclear structure reference, but it should be useful to someone studying decay schemes. Its contents are based largely on responses to recent surveys of applied users.[1]

The *Handbook* will be produced at four year intervals, beginning in 1982. Data will be taken from the current version of ENSDF, with no further updating. Additional calculations and evaluation will be done to provide recommended data on atomic radiations and conversion electrons, and to provide "best" values for $\gamma$-ray properties, independent of the decay parent, in cases where ENSDF does not. Each mass chain will be referenced to the most recent evaluation in the *Nuclear Data Sheets*, as the source for further details and references to the original papers.

The *Handbook* will be ordered by mass number (A) and subordered by atomic number (Z). Each mass chain will consist of:

a) A "skeleton" mass-chain diagram showing the ground states and long-lived isomers with their half-lives, energies (for isomers), spin-parity assignments, decay modes, Q-values, and the decay relationships between the isotopes. Alpha parents and particle-decay daughters pertinent to the A-chain will also be shown.

b) Tabulated data for each isotope or isomer:

natural isotopic abundance
mass excess
thermal neutron cross sections ($\sigma_c$, $\sigma_f$); $\sigma(n,\alpha)$, $\sigma(n,p)$, and
    $\sigma_{abs}$ will be given in a few cases.
half-life
decay mode, genetic branching (the fraction of the decay
    populating each of several isomers in daughter nuclei)
means of production
energies and intensities of all radiations
    $\alpha$ particles
    $\beta^-$ and $\beta^+$ particles
    $\gamma$ rays
    conversion electrons
    x-rays
    Auger electrons
    $\gamma^{\pm}$

protons
"delayed" p, n, $\alpha$, fission
average $e^-$ ($\beta^-$+ce+Auger), $e^+$ ($\beta^+$+pair), photon ($\gamma$+x-ray)

c) A decay scheme for each parent isotope, giving the adopted daughter level energies and spin-parity assignments, $\beta$ and $\alpha$ feeding intensities (and log ft, HF($\alpha$) factors), and $\gamma$-ray energies and intensities.

A proposed format is shown in figure 1. Figure 2 shows a fragment of another mass chain to illustrate the format for reporting genetic branching.

The main table will be supplemented by an energy-ordered $\gamma$-ray table, with the format illustrated in figure 3, and by appendices containing physical constants, spectroscopy standards, atomic binding energies, K x-ray energies and relative intensities, and radiation absorption curves.

Further characteristics, details, and conventions are described in the following comments:

1. Size: The size of the book, as defined here, will be about 1500 pages of size 21.6 by 27.9 cm. Several major components account for most of the bulk. Rough estimates for their contribution to the size of the book, based on 1977 data, are:

| | |
|---|---|
| skeleton schemes | 100 pages |
| $\alpha$- and $\beta$-group listings | 100 pages |
| photon and electron listings | 500 pages |
| detailed schemes | 500 pages |
| energy-ordered $\gamma$-ray table | 100 pages* |

The addition of adopted levels (E, J$\pi$, $t_{1/2}$ in the form of a ladder diagram) would require an extra 400 pages.

2. Uncertainties: Uncertainties will be given in the tables whenever they are available in ENSDF or another source used (see below). Q-values on the skeleton scheme will be given with uncertainty. Other data on the skeleton and detailed schemes will be given without uncertainty, rounded so that the uncertainty in the last place is $\lesssim$5 units.

3. Isotopes: All ground states, as well as isomers with a half-life $\gtrsim$1 s, plus a few "historic" isomers of shorter half-life (e.g., $^{24m}$Na) will be included. Unstable nuclides identified in nuclear reactions, for which no decay properties have been measured, will be omitted.

4. $\gamma$-ray intensities: Absolute photon intensities will be quoted, both in the tabular listings and on the decay schemes. When the uncertainty in the normalization is significant compared to the uncertainties in the relative intensities (the usual case), the stated uncertainties will include only the relative error; the uncertainty in the normalization will be noted separately (see figure 1). When the normalization is unknown, relative intensities will be listed with a comment.

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* This number is very approximate; it depends on what kind of intensity cutoff (if any) is applied.

5. Atomic radiations and conversion electrons: Figure 1 illustrates how these will be presented. Conversion-electron intensities will be calculated from the γ-ray intensities and the assigned multipolarities (or multipolarities deducible from the spin assignments), with the use of theoretical internal conversion coefficients. X-ray and Auger intensities will be calculated from the atomic shell vacancies produced by internal conversion and electron capture. Annihilation radiation will be calculated from the $\beta^+$ and internal pair conversion intensities.

   Some guidelines to limit the inclusion of weak transitions are being formulated, using those developed by M.J. Martin[2] as a starting point.

6. Other data sources: The following data will be derived from sources other than ENSDF:

| | |
|---|---|
| mass excesses, Q-values | A.H. Wapstra and K. Bos, Atomic Data and Nucl. Data Tables 19 175(1977), or a more recent update. |
| abundances, neutron cross sections | Compilations by N.E. Holden |
| means of production | 7th ed. of the *Table of Isotopes*, or more recent source, if available. (It would be desirable to list $E_{max}$ and $\sigma(E_{max})$ for charged particle reactions if a suitable compilation were available.) |

References

1) BNL-NCS-20573 (1975), BNL-NCS-50717 (1977); minutes of the 2nd annual meeting of the Panel on Reference Nuclear Data, October, 1977, and minutes of the 3rd annual meeting of the Panel on Reference Nuclear Data, October, 1978; C.M. Lederer and J.M. Hollander, in *Nuclear Data in Science and Technology*, Vol. II (Proc. Symposium on the Applications of Nuclear Data in Science and Technology, Paris, March 12-16, 1973), p. 449, IAEA (1973); C.M. Lederer, private communication to Sol Pearlstein, September, 1975; H. Münzel and W. Michaelis, *Survey of the Nuclear Data Needs in Activation Analysis*, KFK 1812, INDC (GER)-12/u+w(1973).

2) *Nuclear Decay Data for Selected Radionuclides*, M.J. Martin, ed., ORNL-5114 (1976); *Nuclear Decay Data for Radionuclides Occurring in Routine Releases from Nuclear Fuel Cycle Facilities*, D.C. Kocher, ORNL/NUREG/TM-102(1977).

## Figure 1 (continued)

$^{80}_{38}Sr$ (Continued)

$\beta^+$:

| Energy[a] (keV) | Intensity (%) |
|---|---|
| 189 | 0.04 |
| 225 | 0.02 |
| 542 | 0.18 |
| 603 | 0.26 |
| 778 | 7.2 |

a) Based on systematic decay energy.

$\gamma$:

| Energy (keV) | Intensity[a] (%) |
|---|---|
| 175.0 *5* | 10.4 *10* |
| 235.9 *8* | 4.3 *4* |
| 316.0 *15* | 1.1 *1* |
| 378.8 *5* | 4.3 *4* |
| 414.1 *5* | 3.3 *3* |
| 553.4 *5* | 7.0 *7* |
| 589.0 *5* | 40 |

a) Quoted uncertainties refer to relative intensities; 20% additional uncertainty applicable to absolute intensities.

Other radiations:

| Radiation | Energy (keV) | Intensity (%) |
|---|---|---|
| Rb Auger-L | 1.68 | 100 *3* |
| Rb Auger-K | 11.4 | 27 *1* |
| Rb LX | 1.69 | 1.0 *3* |
| Rb $K_{\alpha_2}X$ | 13.33580 *2* | 15.7 *6* |
| Rb $K_{\alpha_1}X$ | 13.39530 *2* | 30.4 *10* |
| Rb $K_{\beta}X$ | 15 | 7.9 *5* |
| $\gamma^{\pm}$ | | 16 |

Average energies:

$<E_{\gamma+x}>$: 425 *94*

$<E_{e^+}>$: 198

## Figure 2

Illustration of proposed handling of genetic decay branchings

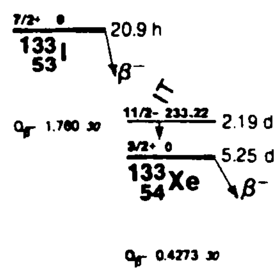
$^{133}_{53}I$

$t_{1/2}$: 20.9 *1* h

$\gamma$: $\beta^-$ (97.12% to $^{133}Xe$; 2.88 *2*% to $^{133m}Xe$)

Δ: -85.902 *31*

Prod: fission

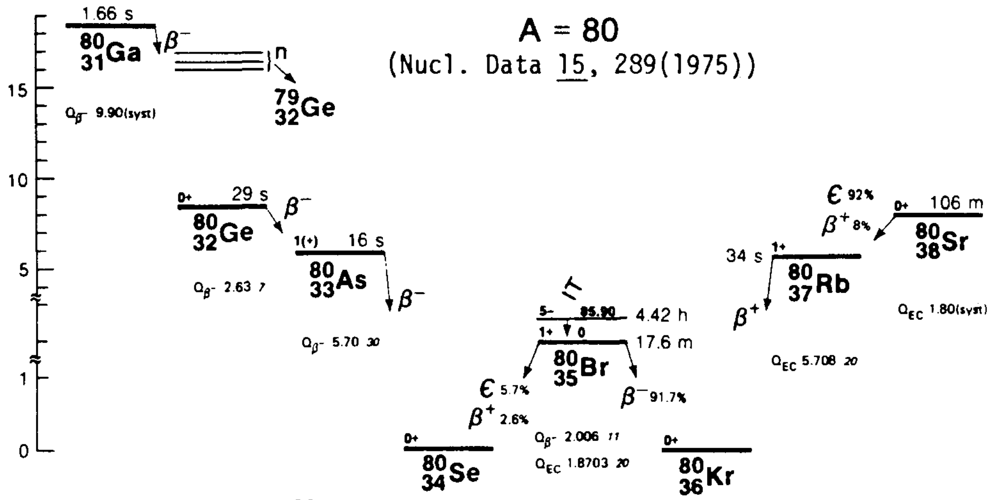



| $E_{\gamma}$(keV) | I(%) | Isotope | $t_{1/2}$ | |
|---|---|---|---|---|
| 230.37 *6* | 27 | $^{226}Ac^{L}$ | 29 h | |
| | 0.12 | $^{230}U$ | 20.8 d | |
| 609.3 *1* | 0.12 | $^{218}Rn(^{230}U)$ | 20.8 d | |
| 616.4 *6* | 7 | $^{80}Br$ | 17.6 m | n |
| | 25 | $^{80}Rb(^{80}Sr)$ | 106 m | |
| 661.661 *3* | 85 | $^{137m}Ba(^{137}Cs)$ | 30.17 y | fn |

## Figure 3

Sample format for the energy-ordered gamma-ray table. (The gamma rays illustrated in the sample were chosen only to illustrate features of the layout.) Several listings under the same energy refer to the same transition (i.e., in the same daughter nucleus) excited by different radioactive parents. An isotope in parentheses following another is a longer-lived parent or ancestor with which the listed gamma ray is more commonly observed; the half-life given is that of the parent. A footnote "L" on the isotope indicates that a longer-lived ancestor exists, but is not the more common source of the gamma ray. An "n" following the half-life column denotes a nucleus produced by neutron capture on natural substances; an "f" denotes a fission product.

# Figure I




## $^{80}_{31}$Ga

$t_{1/2}$: 1.66 2 s
☢: $\beta^-$, $\beta^-$n
Δ: -59.53(syst)
Prod: fission

## $^{80}_{32}$Ge

$t_{1/2}$: 29 s
☢: $\beta^-$
Δ: -69.43 31
Prod: fission

γ:

| Energy (keV) | Intensity[a] (%) |
|---|---|
| 110.4 4 | 6.0 3 |
| 265.6 4 | 25 |
| 782.3 4? | ≈0.8 |
| 937.2 4 | 4.0 4 |
| 1014.0 4 | 2.5 5 |
| 1116.0 4 | 2.6 4 |
| 1256.1 4 | 3.1 4 |
| 1564.3 4 | 4.5 4 |

a) Quoted uncertainties refer to relative intensities; 40% additional uncertainty applicable to absolute intensities.

Average energies:
$\langle E_{\gamma+x}\rangle$: 280 116

## $^{80}_{33}$As

$t_{1/2}$: 16 s
☢: $\beta^-$
Δ: -72.06 30
Prod: $^{80}$Se(n,p), fission

$\beta^-$:

| Energy (keV) | Intensity (%) |
|---|---|
| 1970 300 | 0.1 |
| 2090 300 | 0.2 |
| 2680 300 | 1.0 |
| 2860 300 | 0.2 |
| 2930 300 | 0.3 |
| 3180 300 | 1.2 |
| 3390 300 | 7.1 |
| 3740 300 | 1.3 |
| 3830 300 | 4.2 |
| 4220 300 | 0.5 |
| 4250 300 | 0.9 |
| 5030 300 | 27 |
| 5700 300 | 56 |

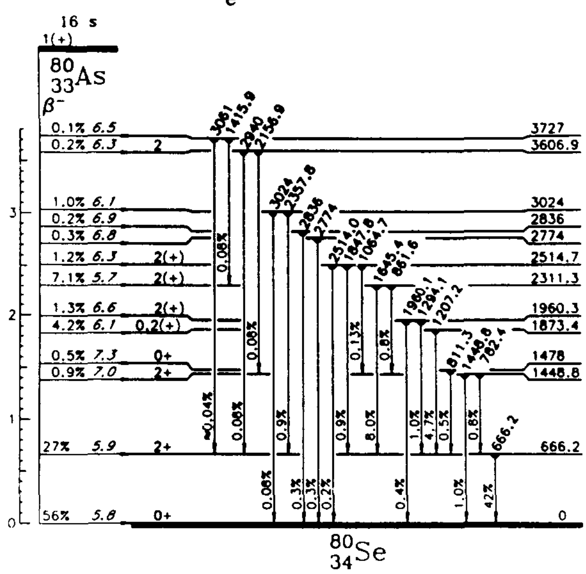
γ:

| Energy (keV) | Intensity[a] (%) |
|---|---|
| 321.2 5? | 5.5 1[b] |
| 666.2 2 | 42 |
| 782.4 5 | 0.80 17 |
| 908.7 5? | 0.71 13[b] |
| 811.3 5 | 0.46 17 |
| 861.6 4 | 0.76 8 |
| 1064.7 5 | 0.13 4 |
| 1207.2 2 | 4.7 4 |
| 1294.1 4 | 1.0 1 |
| 1415.9 5 | 0.08 4 |
| 1422.7 5? | 0.04 4[b] |
| 1448.8 5 | 1.0 1 |
| 1633.3 5? | 1.2 2[b] |
| 1645.4 2 | 8.0 4 |
| 1847.8 5 | 0.9 2 |
| 1960.1 5 | 0.38 8 |
| 1968.8 5? | 0.13 8[b] |
| 2156.9 5 | 0.08 4 |
| 2357.8 5 | 0.9 2 |
| 2461.3 5? | 0.2 1[b] |
| 2514.0 5 | 0.17 8 |
| 2598.1 5? | 0.13 8[b] |
| 2774.2 10 | 0.3 1 |
| 2836.2 10 | 0.25 8 |
| 2940.3 10 | 0.08 4 |
| 3024 2 | 0.08 4 |
| 3060.8 20 | 0.04 4 |

## $^{80}_{33}$As (Continued)

a) Quoted uncertainties refer to relative intensities.
b) If isotopic assignment is correct; γ ray could alternatively be assigned to $^{82}$As.

Average energies:
$\langle E_{\gamma+x}\rangle$: 643
$\langle E_{e^-}\rangle$: 2308




## $^{80}_{34}$Se

%: 49.8
Δ: -77.7613 35
σ: 0.61 6 b (to $^{81}$Se)
0.07 2 b (to $^{81m}$Se)

# Figure I (continued)

## $^{80}_{35}Br$

$t_{1/2}$: 17.6 m
Decay mode: $\beta^-$ 91.7%, ε 5.7 *3*%, $\beta^+$ 2.6 *2*%
Δ: -75.8910 *36*
Prod: $^{79}Br(n,\gamma)$, daughter $^{80m}Br$, $^{79}Br(d,p)$

$\beta^-$:

| Energy (keV) | Intensity (%) |
|---|---|
| 686 *11* | 0.19 *2* |
| 750 *11* | 0.31 *3* |
| 1390 *11* | 6.2 *6* |
| 2006 *11* | 84.9 *7* |

$\beta^+$:

| Energy (keV) | Intensity (%) |
|---|---|
| 848.3 *20* | 2.6 *2* |

γ:

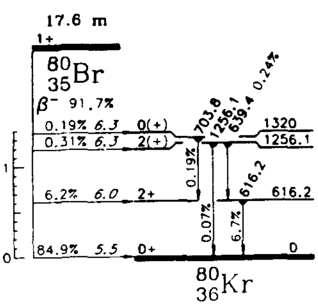
| Energy (keV) | Intensity[a] (%) | Decay mode |
|---|---|---|
| 616.2 *5* | 6.7 | $\beta^-$ |
| 639.4 *2* | 0.24 *2* | $\beta^-$ |
| 666.2 *2* | 1.1 *2* | $\varepsilon+\beta^+$ |
| 677.0 *10*? | 0.008 *2* | |
| 687.4 *10*? | 0.012 *3* | |
| 703.8 *2* | 0.19 *3* | $\beta^-$ |
| 782.4 *5*? | ≤0.013 | $\varepsilon+\beta^+$ |
| 811.3 *5* | 0.033 *7* | $\varepsilon+\beta^+$ |
| 1256.1 *4* | 0.067 *7* | $\beta^-$ |
| 1338.5 *8* | 0.020 *7* | $\beta^-$ |
| 1448.8 *5*? | ≤0.016 | $\varepsilon+\beta^+$ |

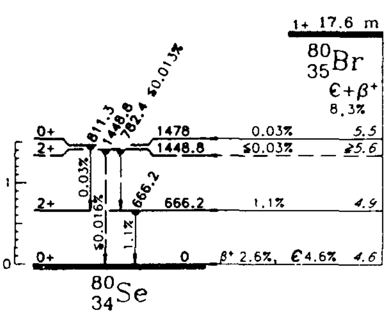
a) Quoted uncertainties refer to relative intensities; 9% additional uncertainty applicable to absolute intensities.

Other radiations:

| Radiation | Energy (keV) | Intensity (%) |
|---|---|---|
| Se Auger-L | 1.32 | 7.0 *7* |
| Se Auger-K | 9.67 | 2.2 *2* |
| Se LX | 1.38 | ∿0.1 |
| Se $K_{\alpha_2}X$ | 11.18140 *2* | 0.9 *1* |
| Se $K_{\alpha_1}X$ | 11.22240 *2* | 1.8 *3* |
| Se $K_\beta X$ | 12.5 | 0.4 *1* |
| $\gamma^\pm$ | | 5.2 *4* |

Average energies:
$\langle E_{\gamma+x}\rangle$: 80 *25*
$\langle E_{e^-}\rangle$: 718 *7*
$\langle E_{e^+}\rangle$: 368 *28*




## $^{80m}_{35}Br$

$t_{1/2}$: 4.42 *1* h
Decay mode: IT
Δ: -75.8051 *36*
Prod: $^{79}Br(n,\gamma)$

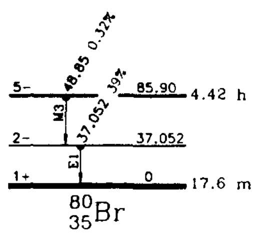
γ:

| Energy (keV) | Intensity (%) |
|---|---|
| 37.052 *2* | 39.1 *8* |
| 48.85 *3* | 0.324 *6* |

Other radiations:

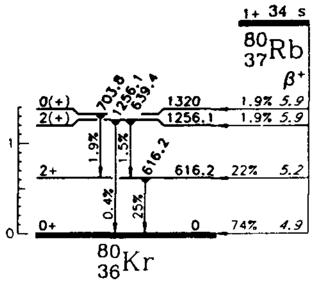
| Radiation | Energy (keV) | Intensity (%) |
|---|---|---|
| Br Auger-L | 1.4 | 176 *35* |
| Br Auger-K | 10.2 | 48 *5* |
| K-37 | 23.578 | 54.0 *15* |
| L-37 | 35.270 | 6.1 *2* |
| K-49 | 35.38 | 72.6 *26* |
| M-37 | 36.795 | 0.95 *3* |
| L-49 | 47.07 | 22.4 *8* |
| M-49 | 48.59 | 3.8 *2* |
| Br LX | 1.48 | 1.6 *4* |
| Br $K_{\alpha_2}X$ | 11.87760 *2* | 23.0 *20* |
| Br $K_{\alpha_1}X$ | 11.92420 *2* | 45 *4* |
| Br $K_\beta X$ | 13.3 | 11.0 *14* |

Average energies:
$\langle E_{\gamma+x}\rangle$: 24 *1*
$\langle E_{e^-}\rangle$: 62 *1*




## $^{80}_{36}Kr$

%: 2.27 (atmospheric sources; variations reported for meteoritic sources.)
Δ: -77.897 *11*
σ: 11.5 *6* b (to $^{81}Kr$)
4.6 *7* b (to $^{81m}Kr$)




## $^{80}_{37}Rb$

$t_{1/2}$: 34 *4* s
Decay mode: $\beta^+$
Δ: -72.190 *23*
Prod: daughter $^{80}Sr$, $^{71}Ga(^{12}C,3n)$

$\beta^+$:

| Energy (keV) | Intensity (%) |
|---|---|
| 3366 *20* | 1.9 *3* |
| 3430 *20* | 1.9 *3* |
| 4070 *20* | 22 *3* |
| 4686 *20* | 74 *3* |

γ:

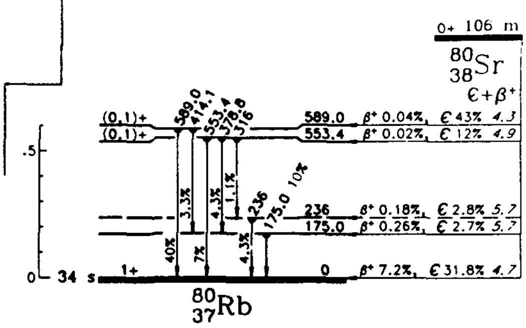
| Energy (keV) | Intensity[a] (%) |
|---|---|
| 616.2 *5* | 25 |
| 639.4 *2* | 1.5 *2* |
| 703.8 *2* | 1.9 *2* |
| 1256.1 *4* | 0.42 *6* |

a) Quoted uncertainties refer to relative intensities; 12% additional uncertainty applicable to absolute intensities.

Other radiations:

| Radiation | Energy (keV) | Intensity (%) |
|---|---|---|
| $\gamma^\pm$ | | 200 |

Average energies:
$\langle E_{\gamma+x}\rangle$: 1204 *188*
$\langle E_{e^+}\rangle$: 2072 *14*




## $^{80}_{38}Sr$

$t_{1/2}$: 106.3 *15* m
Decay mode: ε 92%, $\beta^+$ 8%
Δ: -70.39(syst)
Prod: $^{14}N$ on Ga, $^{65}Cu(^{20}Ne,5n)^{80}Y(\varepsilon+\beta^+)$

(Continued)

Preliminary Results from the Radioactivity Handbook Survey

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Samples illustrating the proposed contents and format for the Radioactivity Handbook have been distributed, along with a survey requesting specific comments and feedback, to other data centers and to members of several professional societies. Approximately 5000 surveys were distributed. To date 685 completed surveys have been returned and tabulated: 116 from recipients of the NNDC newsletter, 127 from the American Nuclear Society's Radiation Protection and Shielding Division, 114 from the Division of Nuclear Chemistry and Technology of the American Chemical Society, 247 from the American Physical Society's Division of Nuclear Physics, 71 from the Isotopes and Radiation Division of the ANS, 9 from the ASTM/E-10 Committee, and 1 from the Health Physics Society.

Figure 1 shows the actual survey, as well as the responses (in % of total replies) to each question. Question I provides some general data on the respondent's type of work and his/her need for nuclear data. Question II defines the specific data that he/she uses. Question III is an attempt to determine if there is a consensus about the optimum size of such a handbook.

A very broad range of occupations and applications of data was evidenced in the replies. A strong cross-linkage between different applications and professions was also evident. We have attempted a rough quantitative breakdown of the results into the following fields of application:

| | | | |
|---|---|---|---|
| Basic: | basic nuclear physics research, nuclear theory, teaching | 273 | (40%) |
| Chem: | activation analysis, isotope production, tracer studies, chemical applications | 133 | (19%) |
| React: | reactor design, reactor safety, fuel rod and shielding design, radioactive waste problems, nuclear engineering | 123 | (18%) |
| Med: | medical diagnostics, radiotherapy, radiopharmaceutical production | 52 | ( 8%) |
| HP: | health physics, radiation dosimetry, radiation protection | 32 | ( 5%) |
| Envir: | environmental studies and monitoring | 35 | ( 5%) |
| Other: | weapons design, safeguards programs, geoscience applications, astrophysics, atmospheric physics, cosmology | 37 | ( 5%) |

Table I summarizes the responses of each group to most of the questions on the survey.

Final conclusions have not been drawn yet from these results; completed surveys are still being received. However, there are some interesting observations. There is a clear mandate to include decay schemes in the Handbook. There were a few comments expressing great satisfaction that absolute photon intensities will be given. Clearly (question II. d) only basic researchers consider spins and parities to be important. However, the inclusion of these quantities on the level schemes will require no additional space and will be useful to a large body of researchers. On the other hand, let us consider isotope production methods which were considered important by slightly more than half of those surveyed. The medical professions, in particular, were very enthusiastic in their response. What they want, however, is a complete entry with reactions, production cross sections, yields, and original references. There is a need for collecting all this data in one place in a usable fashion since no such compilation currently exists. Certainly none of this data is contained in ENSDF. It would therefore require major compilation effort and is probably outside the scope of the Handbook production schedule. Perhaps isotope production would be an appropriate subject for an independent horizontal compilation.

Other types of data requested included charged particle cross sections (8 responses), fission yields (12), shielding factors (6), nuclear moments (10), neutron energies (13), spontaneous fission properties (9), dosimetry data (6), and detailed x-ray data including fluorescence yields (5). Three or four requests were obtained for each of the following: level half-lives, internal conversion coefficients, resonance integrals, the total energy associated with each decay mode, ladder diagrams, $\gamma$-ray multipolarities and mixing ratios, and range-energy curves and tables.

There are two ways to view the results of question III concerning the Handbook size. On the one hand, there is a three-way split between 1) including all the data in one volume, 2) dividing it into 2 volumes on the basis of tabular data and decay schemes, and 3) producing two volumes with a convenient A-chain division. On the other hand, the results can be interpreted as a greater than 2 to 1 preference for a two-volume publication. Some of those scientists who favored publication in one volume also suggested the publication of an additional compact handbook for field use. Another suggestion (5 responses) was to reduce the size by omitting the energy-ordered $\gamma$-ray table. To produce a complete table would require at least 100 pages and would, in large part, duplicate existing compilations. There were a few comments to the effect that 1500 pages were not considered too cumbersome but future editions of the Handbook should not be allowed to grow in size. Half of those who wanted a very compact book (option 3) would achieve it by eliminating decay schemes. The other half would include complete radiation data on the decay schemes and eliminate the gamma and electron listings.

As a final comment, the answers to question IV would indicate that we have a ready audience.

Figure 1: RADIOACTIVITY HANDBOOK SURVEY

Please take a few minutes to let us know your reaction to the contents and format proposed for the Radioactivity Handbook.

I. a) NAME: Total responses 685 (Optional)

OCCUPATION: Foreign responses 54 (8%)

Professional society from which you received this Handbook survey: ______

b) Do you use or encounter radioisotopes, nuclear reactors, or charged-particle accelerators, or deal with nuclear properties in your work?

81% radioisotopes
54% accelerators
52% reactors
73% nuclear properties

c) For what purpose? (Type of application, e.g.: tracers in chemical studies, medical diagnostics, reactor design, etc.)

II. The following data categories are proposed for inclusion in the Handbook. Please indicate the types of data important to you.

95% a) half-lives of radioactive substances

84% b) natural isotopic abundances

67% c) nuclear masses

44% d) nuclear spins and parities

70% e) neutron and fission cross sections

94% f) nuclear decay modes and genetic (parent-daughter) relationships

55% g) isotope production methods

98% h) energies and intensities of radiations:

97% gamma rays
74% x-rays
75% α particles
38% Auger electrons
38% protons
82% β- and β+ particles
____ other radiations (specify)
52% conversion electrons
46% "delayed" p,n,α, and fission data
38% average e⁻ energy ($\beta^-$+ce+Auger)
35% average e+ energy (β+ + pair)
42% average photon energy (γ+x-ray)

84% i) decay scheme for each parent isotope ____j) other types of data (specify)

III. The Handbook, as defined in the attached material, will be ~1500 pages and will include all the above data categories under one cover. There is some concern about the resulting size of such a complete volume. The question then arises as to possible trade-offs between the size of the Handbook and the scope of the data included - portability vs completeness. It can be seen in the Handbook descriptive material that two types of data account for ~2/3 of the bulk - photon and electron listings (500 pages) and decay schemes (500 pages). Any compromise aimed at significantly reducing the size of the Handbook must involve some manipulation and/or sacrifice of at least one of these data categories. Please indicate your feelings about any compromise by checking one of the following three statements.

28% 1) Completeness of the data in a single volume is the most important consideration.

68% 2) Completeness of the data is more important but there should be some compromise with portability. The Handbook should contain all the above data catagories but it should be published as two (or more) smaller volumes. Possible ways to do this are suggested below. Please indicate your preference.

31% a) All tabular data could be contained in one volume (~1000 pages) and decay schemes in a second volume.

32% b) Mass-chain data could be divided into two or more volumes. For example, all data for masses A=1-130 could be published in one volume and all data for A>130 in a second volume.

0.7% c) other (specify)

2.5% 3) Portability is a more important factor than completeness of the data. What data are you willing to give up in order to obtain a more compact book?

0.8% 4) Either 1) or 2)

1% 5) No preference

IV. What is the likelihood that you will use the Handbook defined in the attached material?

| | | |
|---|---|---|
| 75% definitely | 3.6% possibly | ____ definitely not |
| 20% probably | 0.6% not likely | 0.9% no response |

Return to: J.M. Dairiki
Isotopes Project
Bldg. 70A-2255B
Lawrence Berkeley Laboratory
Berkeley, CA 94720

TABLE I

| SURVEY QUESTION | | | FIELD OF APPLICATION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Basic | Chem | React | Med | HP | Envir | Other | Total |
| I. | a) | total responses | 273 | 133 | 123 | 52 | 32 | 35 | 37 | 685 |
| | | foreign responses | 31 | 10 | 10 | 1 | | 2 | | 54 |
| | | | Responses (in %) for each profession | | | | | | | |
| | b) | radioisotopes | 79 | 96 | 56 | 92 | 81 | 94 | 89 | 81 |
| | | accelerators | 82 | 36 | 20 | 73 | 41 | 20 | 49 | 54 |
| | | reactors | 38 | 61 | 87 | 44 | 44 | 49 | 38 | 52 |
| | | nuclear properties | 88 | 59 | 67 | 52 | 59 | 66 | 76 | 73 |
| II. | a) | half-lives | 93 | 97 | 98 | 96 | 84 | 100 | 97 | 95 |
| | b) | abundances | 84 | 89 | 80 | 79 | 78 | 91 | 86 | 84 |
| | c) | masses | 85 | 62 | 60 | 60 | 38 | 29 | 49 | 67 |
| | d) | spins/parities | 85 | 17 | 16 | 15 | 9 | 9 | 27 | 44 |
| | e) | neutron cross sections | 64 | 74 | 82 | 60 | 66 | 63 | 84 | 70 |
| | f) | decay modes | 94 | 92 | 93 | 98 | 91 | 94 | 92 | 94 |
| | g) | production methods | 49 | 59 | 56 | 85 | 66 | 51 | 38 | 55 |
| | h) | radiations | 98 | 98 | 98 | 98 | 100 | 97 | 95 | 98 |
| | | gamma rays | 97 | 97 | 98 | 96 | 100 | 97 | 95 | 97 |
| | | x-rays | 70 | 82 | 67 | 90 | 88 | 71 | 70 | 74 |
| | | $\alpha$ particles | 81 | 69 | 72 | 71 | 91 | 83 | 51 | 75 |
| | | Auger electrons | 42 | 29 | 28 | 67 | 66 | 31 | 16 | 38 |
| | | protons | 49 | 22 | 34 | 46 | 47 | 20 | 27 | 38 |
| | | $\beta^{\pm}$ particles | 81 | 83 | 78 | 94 | 97 | 86 | 65 | 82 |
| | | conversion electrons | 63 | 42 | 40 | 67 | 66 | 34 | 27 | 52 |
| | | delayed particles | 49 | 36 | 62 | 35 | 41 | 23 | 51 | 46 |
| | | ave $e^-$ energy | 30 | 38 | 42 | 63 | 69 | 37 | 27 | 38 |
| | | ave $e^+$ energy | 29 | 30 | 39 | 63 | 69 | 31 | 24 | 35 |
| | | ave photon energy | 30 | 35 | 56 | 63 | 75 | 40 | 49 | 42 |
| | i) | decay schemes | 87 | 83 | 79 | 94 | 81 | 74 | 84 | 84 |
| III. | 1) one volume | | 30 | 26 | 22 | 33 | 34 | 31 | 19 | 28 |
| | 2) two volumes | | 67 | 69 | 72 | 61 | 66 | 57 | 73 | 68 |
| | | a) division by data category | 24 | 35 | 35 | 37 | 25 | 37 | 38 | 31 |
| | | b) division by A chain | 38 | 29 | 34 | 23 | 34 | 14 | 24 | 32 |
| IV. Usage | | | | | | | | | | |
| | definitely | | 80 | 76 | 65 | 82 | 69 | 60 | 76 | 75 |
| | probably | | 17 | 16 | 28 | 10 | 25 | 34 | 24 | 20 |

Appendix 18

## Structure and Contents of the Future Nuclear Structure Reference File

C.L. Dunford, National Nuclear Data Centre
February 1, 1980

### I. Structure of Nuclear Structure Reference File

The basic structure of the Nuclear Structure References[1] file will remain unchanged. It will use the ADSEP format with logical records initiated by a ten character identifier. The file will contain 80 character physical records with the start of each logical record coinciding with the beginning of a physical record.

The legal record identifiers are:

```
<KEYNO     > - Reference keynumber
<HISTORY   > - Administrative record  (new)
<CODEN     > - Standard form reference
<REFERENCE> - Free text reference
<AUTHORS   > - Author names
<TITLE     > - Reference title
<KEYWORDS > - Keyword abstract
<SELECTRS > - Indexing parameter list
```

Only these record types will appear in the file and they will appear in the above order. Only one record of each type will appear in the file for each reference, except for <KEYWORDS> and <SELECTRS> which will be repeated for each major category (i.e., NUCLEAR REACTIONS, NUCLEAR STRUCTURE, etc.) under which the reference is indexed. There will not be separate complete entries with the same key number as in the past.

#### A. <KEYNO>

The record contents will remain unchanged. The keynumber will be six characters; the first two, the publication year; the second two, the first two letters of the first author's last name; and the final two a unique identifier (2 digits for a primary reference or 2 letters for a secondary reference).

The only change will be to make the keynumber all upper case (e.g. 76LA03 instead of 76La03).

Ex.:

```
<KEYNO     >76LA03   primary
<KEYNO     >76MEZY   secondary
```

B. <HISTORY>

This is a new record. It will contain a single character code followed by a date in the form YYMMDD.

The possible codes are:

A - added
M - modified
D - deleted
C - compiled (NNDC use only)

| | | | |
|---|---|---|---|
| Ex.: | <HISTORY | >A800211 | New reference entry |
| | <HISTORY | >M791122 | Modified reference entry |
| | <HISTORY | >D800101 | Deleted reference entry |

C. <CODEN>

The record contents will be essentially unchanged. The field will consist of a reference-type code of variable length terminating with a blank. The short form of the reference will then follow.

The permitted reference types are:

JOUR - Journal
CONF - Conference
REPT - Report
BOOK - Book
PC - Private Communication
THESIS - Thesis
PREPRINT - Preprint.

The only change will be the introduction of the code JOUR for journal. Previously there was no reference type code preceding the CODEN for a journal.

D. <REFERENCE>, <AUTHORS>, <TITLE>

These are free text fields with no changes in structure or content proposed. All primary references must have these three records.

E. <KEYWORDS>

No changes. The allowed major categories are:

NUCLEAR MOMENTS
RADIOACTIVITY
NUCLEAR REACTIONS
NUCLEAR FISSION (obsolete)
ATOMIC PHYSICS
ISOTOPE SHIFTS
NUCLEAR STRUCTURE
ATOMIC MASSES
COMPILATION

F. <SELECTRS>

This field has been totally redesigned to improve processing and retrieval capability. It will be an all upper case field with entries for each indexable parameter for the reference.

The format of each entry is as follows:

(parameter type):(parameter value);(link variable).

Entries are placed successively in the record separated by a single blank. The valid parameter types are:

- N - Nuclide or element for which structure or decay information is presented.
- T - Target nuclide or element in a reaction.
- R - Reaction
- S - Special subject or minor category
- M - Measured quantity
- D - Deduced quantity
- C - Calculated quantity
- X - Compiled or evaluated quantity.

Dictionaries of valid entries (parameter values) are available on request.

<SELECTRS>N:249CF;A. M:G-SPECTRA;A. M:A-DECAY;A. N:245CM;B. D:T1/2;B.
<SELECTRS>T:325;A. T:160;A. R:(N,P);A. M:DSIGMA;A.

## II. Character Sets To Be Used for Nuclear Structure References

The extended 8-BIT EBCDIC character set previously defined by ORNL NDP is given in ORNL-5397. The table given on page 2 (Fig. 1) is incorrect. The proper character set is given on page 16 (Fig. 16) with the Cyrillic characters deleted. The Nuclear Structure References file does not use the entire set as defined.

Attached are three character sets which will be defined and available to recipients of the Nuclear Structure References file in the future. Only those characters defined in the 8-BIT EBCDIC system will be permitted. One new character, a superscript g has been defined. Several unused or little used characters have been eliminated.

Two other sets will be defined for users who do not have 8-BIT character capability on their computers. These are a 7-BIT system with control characters to get superscript, subscript and other nonstandard characters. This system will be used internally at NNDC and will be available in standard 8-BIT EBCDIC. Finally there will be a 6-BIT system in which superscripting, subscripting and nonstandard characters are not allowed. The 8-BIT and 7-BIT systems are compatible and no information is lost translating from one to another. The 6-BIT system represents a degradation of the information in the file. The mapping from 7-BIT to 6-BIT is described later in this document.

## A. EXTENDED EBCDIC SET

| Decimal | Hexadecimal | Character | |
|---|---|---|---|
| 31 | 1F | ∿ | |
| 33 | 21 | κ | |
| 34 | 22 | Γ | |
| 35 | 23 | τ | |
| 36 | 24 | ϕ | |
| 37 | 25 | Θ | |
| 40 | 28 | σ | |
| 41 | 29 | λ | |
| 42 | 2A | ρ | |
| 43 | 2B | δ | |
| 44 | 2C | ε | |
| 45 | 2D | Δ | |
| 46 | 2E | Σ | |
| 53 | 35 | m | (superscript) |
| 54 | 36 | g | (superscript) |
| 65 | 41 | → | |
| 75 | 4B | . | |
| 76 | 4C | < | |
| 77 | 4D | ( | |
| 78 | 4E | + | |
| 92 | 5C | * | |
| 93 | 5D | ) | |
| 94 | 5E | ; | |
| 96 | 60 | - | |
| 97 | 61 | / | |
| 107 | 6B | , | |
| 108 | 6C | % | |
| 110 | 6E | > | |
| 112 | 70 | 0 | |
| 113 | 71 | 1 | |
| 114 | 72 | 2 | |
| 115 | 73 | 3 | |
| 116 | 74 | 4 | numeral |
| 117 | 75 | 5 | subscripts |
| 118 | 76 | 6 | |
| 119 | 77 | 7 | |
| 120 | 78 | 8 | |
| 121 | 79 | 9 | |
| 122 | 7A | : | |
| 125 | 7D | ' | |
| 126 | 7E | = | |
| 129 | 81 | a | |
| 130 | 82 | b | |
| 131 | 83 | c | |
| 132 | 84 | d | |
| 133 | 85 | e | |
| 134 | 86 | f | |
| 135 | 87 | g | |

| Decimal | Hexadecimal | Character | |
|---|---|---|---|
| 136 | 88 | h | |
| 137 | 89 | i | |
| 140 | 8C | ≤ | |
| 142 | 8E | + | (superscript) |
| 145 | 91 | j | |
| 146 | 92 | k | |
| 147 | 93 | ℓ | |
| 148 | 94 | m | |
| 149 | 95 | n | |
| 150 | 96 | o | |
| 151 | 97 | p | |
| 152 | 98 | q | |
| 153 | 99 | r | |
| 154 | 9A | α | |
| 155 | 9B | β | |
| 156 | 9C | γ | |
| 158 | 9E | ± | |
| 160 | A0 | - | (superscript) |
| 161 | A1 | ν | |
| 162 | A2 | s | |
| 163 | A3 | t | |
| 164 | A4 | u | |
| 165 | A5 | v | |
| 166 | A6 | w | |
| 167 | A7 | x | |
| 168 | A8 | y | |
| 169 | A9 | z | |
| 171 | AB | μ | |
| 172 | AC | π | |
| 173 | AD | [ | |
| 174 | AE | ≥ | |
| 176 | B0 | 0 | |
| 177 | B1 | 1 | |
| 178 | B2 | 2 | |
| 179 | B3 | 3 | |
| 180 | B4 | 4 | numeral |
| 181 | B5 | 5 | superscripts |
| 182 | B6 | 6 | |
| 183 | B7 | 7 | |
| 184 | B8 | 8 | |
| 185 | B9 | 9 | |
| 189 | BD | ] | |
| 190 | BE | ≠ | |
| 193-201 | C1-C9 | A-I | |
| 209-217 | D1-D9 | J-R | |
| 222-233 | E2-E9 | S-Z | |
| 240-249 | F0-F9 | 1-9 | |

B. Extended 7-BIT ASCII Set

STANDARD AND #1 ALTERNATE CHARACTER SETS

| Octal | XX0 | XX1 | XX2 | XX3 | XX4 | XX5 | XX6 | XX7 |
|---|---|---|---|---|---|---|---|---|
| 04X | (blank) | ! | " (overscore) | # § | $ ∫ | % √ | & ≡ | ' ° (degree) |
| 05X | ( ← | ) → | * × (times) | + ± | , , | - ∓ | . ˙ . | / ' |
| 06X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 07X | 8 | 9 | : † | ; ‡ | < ≤ | = ↖ | > ≥ | ? ≈ |
| 10X | @ – | A A | B B | C H | D Δ | E E | F Φ | G Γ |
| 11X | H X | I I | J | K K | L Λ | M M | N N | O O |
| 12X | P Π | Q Θ | R P | S Σ | T T | U Υ | V ∇ | W Ω |
| 13X | X Ξ | Y Ψ | Z Z | [ { | \ (back space) \| | ] } | ^ ↑ | _ ↓ |
| 14X | ` ℓ | a α | b β | c η | d δ | e ε | f φ | g γ |
| 15X | h χ | i ι | j | k κ | l λ | m μ | n ν | o o |
| 16X | p π | q θ | r ρ | s σ | t τ | u υ | v ∂ | w ω |
| 17X | x ξ | y ψ | z ζ | begin ({)string | (\|)set #1 | end (})string | set (~)#2 | |

Note: The leftmost character in each box is the standard character for the given octal number, the rightmost character is the alternate character for that octal number. Any character preceded by a |, (174 octal) is the representation for the alternate character. Superscripts and subscripts are denoted by enclosing the appropriate string in braces (octal 173, octal 175) with a + or - following the opening brace (octal 173). Superscript {+ ____} and subscript {- ______}.

## C. SIX-BIT ASCII SYSTEM

In this system the contents of the <REFERENCE>, <AUTHORS>, <TITLE>, and <KEYWORDS> records are the only records affected by the degradation from the 7-BIT to the 6-BIT character set.

The rules for this conversion are as follows:

1. All lower case goes to upper case.
2. All subscript numerals become standard numerals.
3. All superscript numerals become standard numerals.
4. All Greek letters are spelled out with a blank terminator if no blank, period, dash or similar follow the Greek character.
5. Superscript m and g become M- and G-, respectively.
6.

| | |
|---|---|
| ≈ | APPROX. EQUAL |
| → | TO |
| ≥ | GE |
| ≤ | LE |
| ± | PM |
| [ | ( |
| ] | ) |
| | NE |
| super +,-,(,) | +,-,(,), respectively |

## IV. References

1. W.B. Ewbank, "The Nuclear Structure References (NSR) File," ORNL-5397 (1978).

Proposal for the NSDD network meeting

A Reference file for ENSDF

J. Blachot

The ENSDF file contains only the keynumbers (Ex: 79 BR 07, 79 KA 01 ... etc...). The physicists who are using this file, are not able to identify the keynumbers with the actual reference citation (e.g. author, journal, volume, page).

Two proposed solutions are given:

(1) - A second file, where all the keynumbers in ENSDF are ordered by year and alphabetically:

- 76 CH 30; S. CHOJNACKI, et al ACTA PHYSICA POL.B7, 823 (1976)
- 77 NA 05, A.M. NATHAN, et al PHYS. REV C 15,1448 (1977)
  only one keynumber, one reference for a record (80)

(2) - A second file, where all the keynumbers in ENSDF are ordered by year, alphabetically, and by A.

- 116 76 CH 30, S. CHOJNACKI, et al, ACTA PHYSICA POL B7,823 (1976)
- 116 ......
  only one A, one keynumber and one reference for a record (80)

  A blank card when A is changed.

  Solution (2) is preferable because:

- the user needs to look at a less number of references
- when a mass is revised, only the references for this A have to be changed.

---

MEMO NS - 1/A/11

Date: April 8, 1980

From: Charles L. Dunford CLD
National Nuclear Data Center
Brookhaven National Laboratory
Upton, New York 11973 USA

From: References in ENSDF

In response to J. Blachot's proposal, NNDC suggests that a separate file in an ENSDF - like format be maintained by NNDC. This file would be distributed to the network at the same time as the regular ENSDF distribution. It would consist of one ENSDF data set per mass chain sorted by mass number. The set would consist of an ID record, one record for each reference cited in the mass chain sorted by keynumber and a terminating (blank) card.

An example : col. 8 col. 10

```
111      REFERENCES
111     R 63AB03 JOUR ZPAAD A110 35
111     R 72NA35 JOUR JUPSA 21 355
111     R 75KRZA REPT LBL-3728,P21
             (blank card)
```

Network evaluators would not be required to provide this reference file. It would be produced by NNDC from the ENSDF file for that mass chain during the prepublication processing at NNDC. Implementation would be made during 1981.

Appendix 20

## Proposals on ENSDF

1. The F- or Format record is not handled by most analysis programs and its presence in ENSDF is more of a nuicance than a help, in particular since the COMMENT field or cards can usually be used to store special types of information. We should like to suggest that this card type be abolished.

2. Retrieval from ENSDF is playing a role of growing importance. More attention should be paid to uniform standards. For example BE2 values should be placed on 2nd level cards and not on COMMENT cards etc. . More uniformity is also needed in the application of evaluation rules and among reviewers.

3. The new Tables of Conversion Coefficients (Pauli et al.) should replace the old Hager-Seltzer Tables in HSICC.

4. Responsibility should be assigned for
   (1) the technical correctness of the ENSDF-File (formal errors
   (2) contents of the file in the different mass regions.

   Sometimes valuable horizontal evaluations are made using new data from the literature. Some mechanism should be found for assuring that this new information is entered into the ENSDF-file.

5. A uniform way of entering delayed neutron emission data into ENSDF has to be found.

6. The present method of calculating gamma branching ratios from different gamma data sets is not satisfactory. We are suggesting an alternative method.

Appendix 21

## Retrieval from ENSDF: INKARET System

J.W.Tepel and P.Luksch

The evaluated nuclear structure data file or ENSDF is a small but highly structured numerical data file on properties of atomic nuclei. It is organized in units of logically related information or "data sets", each of which describes the results of a single experiment or the combined evaluated results of many experiments of the same type. Retrieval is by means of identification records, and a host of data analysis programs have been developed mainly by the Nuclear Data Project, Oak Ridge National Laboratory, which use these data sets as input for further calculations.

In order to improve the retrieval capabilities from ENSDF the data file was restructured as an ISAM file with a special 16-digit key. This key is designed in such a manner that a key-ordered sequence of records is identical for all practical purposes to the order in the original ENSDF file. However, in contrast to the old system, where retrieval was purely data set-wise, direct retrieval of individual records is now possible. This feature is particularly useful for horizontal compilations, where special properties are selected from the file for many different nucleides.

The 16 digit key represents the tree structure inherent in ENSDF and consists of the following parts:

$$\underbrace{0000}_{C1}\ \underbrace{00}_{C2}\ \underbrace{000}_{C3}\ \underbrace{000}_{C4}\ \underbrace{LC}_{C5}\ \underbrace{00}_{C6}$$

Here the four digit number C1 identifies the isotope, C2 the data set belonging to this isotope (00 is used for the ADOPTED LEVELS) and C3 numbers the level cards in the data set. C3=000 refers to all records being physically placed before the first level card. C4 numbers the radiation emitted from a particular level or in the case of beta-radiation, terminating at that level. C5 denotes the type of record: allowed types are bb (ID-record), Cb, Lb, Gb, Bb, Eb, Ab, Qb, Nb, Pb, LC (comment to level card), etc. (note that b is a blank space). For details of the allowed type of records we refer to the ENSDF manual: ORNL-5054/R1 by W.B.Ewbank and M.R.Schmorak. In this scheme the first comment record belonging to the second gamma leaving the 31st level of the data set 12 belonging to the isotope 86SR=0478 can be written: C1 C2 C3 C4 C5 C6 = 0478 12 031 002 GC 01 . Obviously, similar examples can readily be constructed. Printing the adopted level cards of 86SR would here involve selecting all records of type 0478 00 C3 000 Lb 00 with C3 varying from 001 to some maximum value.

The retrieval program RET.ALL makes use of these keys by looking up the isotope number C1 in a list as a function of A and Z. Restrictions may be placed on the data set as represented by the ID or identification record or on individual records inside the data set. Each record field as defined in the Evaluation Manual can be accessed. Valid search formulations would be:

```
FIND  DSET with A=10-20  Z=5-7  'DECAY'
LIST  CARD=P with  T=1s-10m
END
```

This formulation results in Parent records of DECAY-data sets with A=10-20 and Z=5-7 being listed, where in addition the half-life must be in the range 1s to 10min.

The related formulation:

```
LIST DSET with A=10-20  Z=5-7 'DECAY'
FIND CARD=P with T=1s-10m
END
```

results in the whole data set being printed.

String searches can be made on any type of card:

```
FIND  DSET with A=40-80 'COULOMB'
LIST  CARD=L2 with COM='BE2'
END
```

This formulation results in BE2-values being printed in the range A=40-80. It is assumed that these values appear on 2nd level cards.

It is also possible to formulate more involved questions placing restrictions on more than one field of any particular record.

AVAILABLE FORMATS FOR MAGNETIC TAPE AT BNL-NNDC

| TRACK / MODE / BPI | 7<br>BCD<br>(6 BITS) | 9<br>EBCDIC<br>(8 BITS) | 9<br>ASCII<br>(8 BIT) |
|---|---|---|---|
| 200 BPI | | X | X |
| 556 BPI | | X | X |
| 800 BPI | | | |
| 1600 PE | X | | |
| 6250 GCR | X | | |

Please indicate format of magnetic tape required.

BLOCKING FACTOR (BF) = logical records/Physical record
A Typical logical record is 80 characters
(Example: an 80 character card image).

A Physical record is a block on a tape separated by interrecord gaps.

A usual user requested format is 80/100 where 80 is logical record length and 100 is the BF.

PLEASE indicate the BF you require [ ]

COMPUTER TYPE ____________________

NAME: ________________________________

AFFILIATION: ____________________________

Indicate which of the following tapes you would like to receive on a regular basis.

| File/Programs | YES | NO |
|---|---|---|
| 1. ENSDF | | |
| 2. NSR | | |
| 3. Analysis Codes | | |
| 4. Other (specify) ____________________ | | |

GENERAL REMARKS ON FORMAT AND PRESENTATION OF NUCLEAR DATA SHEETS (NDS)

by

P.M. Endt

1. The NDS are compilations rather than reviews. Data from different reactions are strictly separated except in the master tables which present adopted values for $E_x$, $T_{1/2}$ and $J^\pi$. Generally it is difficult for the reader to judge how the adopted values were arrived at by the compiler and which source papers did contribute. The reader badly misses (for each nucleus):

a) a table in which all measured $E_x$ values of sufficient accuracy (from different reactions) are listed, with the last column giving the adopted values;

b) an analogous table for $T_{1/2}$, including results from $(\gamma,\gamma)$, (e,e') and Coulomb excitation;

c) a table listing the strong arguments used for the $J^\pi$ assignments (for examples see the most recent A = 21-44 review). The attempts made in this direction in the NDS master tables are generally incomplete (no arguments given for the majority of the levels), the relevant reactions are often not indicated ("$\ell=1$" or "$\gamma(\theta)$" gives too little information), whereas the relevant source papers are never given. For some nuclei (e.g. $^{58}$Co) so many reactions are quoted as relevant for $J^\pi$ assignments that the compiler could as well advise the reader to find out for himself.

Conclusion. The available information should be organised in tables each dealing with a given nuclear property ($E_x$, $T_{1/2}$ etc.) rather than with a given reaction. Other properties which should get their special table are: $\gamma$-ray branching ratios, mixing ratios, conversion coefficients (with the theoretical values for pure EL or ML character included), and $\ell$-values and spectroscopic factors from single-nucleon transfer reactions. The "property tables" can almost altogether replace the "reaction tables" and the "reaction drawings" (see below).

2. The "reaction drawings" presenting the information from a given reaction in a level scheme are superfluous, incomplete, often unclear, often misleading, and actually may make data retrieval for the reader more difficult.
As an example one might consider γ-ray branching ratios which are treated most stepmotherly by NDS compilers. The drawing (e.g. on γ-rays from $\beta^-$ decay) is superfluous because (almost) the same information is presented in the corresponding table, many pages later. The drawing is incomplete because the relevant source paper(s) is (are) not mentioned, and because errors in $E_\gamma$, $E_x$ and branchings are lacking. The drawing is often unclear (or impractical) because of the very small level separations often observed (see A = 45, drawing 12); the trick to draw part of the level scheme on scale <u>and</u> at equal distances does not really make matters clearer because the correspondence between the two systems may get lost (see e.g. A=45 drawing 7, A=46 drawing 12, or A=53 drawing 13). The drawing is misleading if < and > signs in front of γ-ray intensities are missing (see A=49 drawing 11 part 3).
Finally, data retrieval may be encumbered rather than facilitated by the presence of drawings, because the relevant information (e.g. on branchings) is spread out over still more pages. For $^{45}$Sc, eight drawings and ten tables present information on γ-decay. The first γ-ray drawing and the last γ-ray table are 41 pages apart. The first and last table are 26 pages apart; the reader has to look under $^{45}$Ca, $^{45}$Sc and $^{45}$Ti because of the NDS custom to list γ-rays from β-decay under the mother nucleus (on which they have very little bearing) rather than under the daughter nucleus. The only information in the drawings not present in the tables is the placement of γ-rays in the level scheme. This is only because in most tables γ-rays are listed in order of increasing $E_\gamma$, instead of in order of increasing $E_x$ of the initial state. Because the drawing supplies the placement and the corresponding table the branching errors, the reader has to leaf back and forth many times in order to construct a proper decay scheme. To arrive at a set of best (or adopted)

values for the branchings the reader has to go through this procedure for every reaction with a relevance on γ-decay, and usually he has to consult the most important source papers (also because some tables only present "selected γ-records"; see A=47 p.89). This job is made still more lengthy because γ-ray intensities (for a given nucleus) from different reactions are often normalized in different ways; one may find (hopefully) 100 for the total decay from a given level, but also 100 for the strongest γ-ray in that decay, or 100 for total β-decay, or 100 for the strongest γ-ray in β-decay. Only the first normalization produces correct branching percentages, useful for the calculation of γ-ray strengths, which is without doubt the most important physical information to be obtained from branchings.

The tables "Adopted gamma's" in some recent NDS issues go some way to alleviate these problems, but they are still far from ideal. No reactions or source papers are mentioned and thus the reader cannot check the correctness and the origin of the adopted values. Mostly transitions are still listed in order of increasing $E_\gamma$, such that one has to go back to the corresponding drawing for their placement (e.g. for A=62). Some of these tables [e.g. for A=46, 62 and 84 (new)] do not use the best normalization system, for some ($^{46}$Ti) the normalization is not indicated.

The most compact and best surveyable method of presenting adopted branching percentages is by way of a matrix in which rows and columns are indexed by the $E_x$ and $J^\pi$ values of initial and final states, respectively.

Some particularly unhappy examples of the listing of branching ratios are given in note 6.

The method followed in some older reviews to put the master tables (summary sheets) together, often separated from the reaction tables (data sheets) by many pages, has luckily been given up in the more recent issues.

3. The presentation of the data is of remarkable inhomogeneity. Some data are given at great (superfluous) length, other important data are lacking.
It is unnecessary to present the γ-decay of, say, 30 generally poorly resolved (p,γ) resonances in many drawings and tables (see e.g. A=54), which swamp the more interesting information from other reactions.
It is also unnecessary (and even misleading) to present $A_2$ and $A_4$ values characterizing γ-ray angular distributions or γ-γ angular correlations. The reader does not know whether detector solid angle corrections have been applied nor, for the angular distributions, which orientation parameters have to be used in the analysis or at which energy the data were taken (see e.g. A=55 p.525, A=86 p.596, A=87 (1979) pp. 422, 426 and 427). In other words, these values are useless for the NDS reader.
Lacking is, on the other hand, in about half of the NDS issues covering the A = 45-90 region, all information on (n,n) or (n,γ) resonances. In most issues not even 73Mu14 is quoted, the most recent Brookhaven report on neutron cross sections.
For (n,γ) spectra it is often not mentioned (e.g. A=46 p.29) that they were taken at $E_n = E_{thermal}$.

4. Some remarks on notation and symbols.
a) It is not explained in the latest list of symbols that B(Λ) mostly means B(Λ↑). Sometimes (to confound the reader) it also means B(Λ↓) (see A=46 p.26, and A=58 p.511). Neither does the list of symbols mention that B(E2) is expressed in the (outmoded) unit $e^2b^2$ instead of in $e^2fm^4$.
b) For A=73 one finds εB(E2) on p.324 and $\varepsilon_\gamma$B(E2) on p.325. Neither of the ε's is given in the list of symbols, but ε(γ) is given.
c) The advisability of listing dubious (non-unambiguous) $J^\pi$ values and the best notation for them have been the subject of some discussion. The theoretician would like to see probable $J^\pi$ values listed, whereas the experimenter would rather know which $J^\pi$ possibilities are remaining, not excluded by previous work. It is our

conviction that for A-chain reviews only the latter method is correct. A good case is the notation $(1/2)^-$ frequently used in NDS. It generally appears to mean that the possibilities are restricted to $1/2^-$ and $3/2^-$ (e.g. from $\ell = 1$ in single-nucleon transfer), but that a weak argument (e.g. the shell model) favours J = 1/2. The weak arguments, however, should be strictly absent from A-chain reviews (the reviewer also has an educational duty!). The only correct notation is $(1/2,3/2)^-$, also used frequently in NDS; the notation $1/2, 3/2^-$ is certainly objectionable (A=71 p.215). It should be noted that brackets serve here to group together $J^\pi$ possibilities in a compact way, rather than to indicate uncertainty (as used for energies etc.). This leads in a natural way to $(1/2-5/2)^+$ for $1/2^+$, $3/2^+$ or $5/2^+$, and to $(1/2-5/2^+)$ for $1/2^\pm$, $3/2^\pm$ or $5/2^+$.

d) The symbol α is often misleading because it is not clear whether it stands for theoretical or experimental conversion coefficients (see A=46 p.26, A=58 p.496, A=74 p.538, A=76 pp 548 and 549, A=77 p.265).

e) The symbol $S' = S(2J_f+1)/(2J_i+1)$ is fine for stripping but it definitely should not be used for pick-up (see A=59, drawing 9).

f) In the master tables the ground state is indicated as $E_x = 0.0$. Why this arbitrary number of zero's after the decimal dot? Replace by $E_x = 0$.

g) It has become general practice to use $\ell$ for the orbital angular momentum transfer in single-nucleon transfer reactions, and to reserve L for the transfer of two or more nucleons. Couldn't NDS also accept this informative notation?

5. Some remarks on conventions and presentation.

a) Entries in the column Mult. (multipolarity) used in many tables (see e.g. A=48 p.25) are ambiguous. It may mean that the entry is assumed by the compiler, or in a source paper (which paper?), or that it is consistent with measurements in the source paper, or that these measurements exclude anything but the entry.

The same ambiguity is shown by the entry "$\delta$=0" (see e.g. A=54 p.506).

b) It is understood that NDS sticks to the sign convention for $\delta$ of 70Kr03. The wrong sign, however, is used many times (e.g. A=59 p.508, A=61 p.18, A=67 p.437). The sign muddle is very bad for A=54 p.502 249.9 keV level. Here $\delta$ = +0.09 $\pm$ 0.04 and −0.11 $\pm$ 0.04 are averaged to +0.10 $\pm$ 0.04. Apparently, the second source value is given with the wrong sign? And why not average to +0.10 $\pm$ 0.03?
The NDS rule to write $\delta$ = 0.09 instead of +0.09 (even if the + sign has been well determined) also leads to ambiguities, e.g. for A=65 p.364 $E_\gamma$ = 771 keV it should be $\delta = \pm 0.09 \pm 0.02$ (or $|\delta| = 0.09 \pm 0.02$).

c) Although not stating this always explicitly, NDS generally presents photon branchings instead of total branchings. This is not true, however, for A=77 drawing 2 part 1, or A=81 drawing 5 ($\gamma$-decay of $^{81}Se^m$).

d) In the drawings the transitions from a given level should be entered systematically. In A=45 drawing 8 the most energetic transition is on the right, in drawing 9 on the left (except for the 1303.5 keV level); drawing 12 shows the same lack of system.

e) References to internal reports or private communications are only useful if the institution or laboratory is indicated (see e.g. 77MeZP, A=56 p.55).

f) The critical compiler should not blindly copy information from source papers. If, for example, in the source paper the errors assigned to the branching percentages in a two-branch decay are not equal, the compiler should make them equal (see A=54 p.502 for the 1009 and 1137 keV levels).

g) If the source paper only lists statistical errors for DSA $T_{1/2}$ results, the compiler should add (in quadrature) a reasonable systematic error, say 15%. An error like 3.5% (A=48 p.44, 3240 keV level) is quite irrealistic. The weighted average of several DSA results should not have an error smaller than, say, 10%.

h) By combining information from different source papers and by applying the recommended upper limits for $\gamma$-ray strengths in the introduction of every NDS issue the compiler can often arrive at $J^\pi$ assignments not given in any of the source papers. This could have been done e.g. for the 281 keV level in $^{46}Sc$ ($J^\pi = 5^+$, the strength of the 1124 → 281 keV transition excludes $6^+$), the 1140 keV level in $^{51}$Mn ($J^\pi = 9/2^-$, with $9/2^+$ excluded by the large mixing ratio of the 1140 → 237 keV transition given on p.219), the 839 keV level in $^{54}$Mn ($J^\pi = 4^+$), the 4072 and 4949 keV levels in $^{54}$Fe ($J^\pi = 3^+$ and $4^+$, respectively), the 886 keV level in $^{58}$Co ($J^\pi = 4^+$), the 1733 keV level of $^{61}$Cu ($J^\pi = 7/2^-$), the 175 keV level of $^{71}$Ge ($J^\pi = 5/2^-$).

i) If the large value of a two-valued δ-measurement can be rejected on the basis of γ-ray strength arguments, the compiler should do so. This applies to A=47 p.89 ($E_\gamma$ = 1195, 1297 and 1405 keV), A=49 pp. 228 ($E_\gamma$ = 394 and 855 keV) and 232 ($E_\gamma$ = 1140 keV), A=54 p.494 ($E_\gamma$ = 471 keV).

j) The master table should really present "best" values. For $T_{1/2}$ not only direct DSA and RD results should be used, but also the B(Λ↑) from (γ,γ), (e,e') and Coulomb excitation. This has not been done for A=48 p.22 ($E_x$ = 3832 and 4507 keV), A=54 p.484 ($E_x$ = 1824 keV), A=60 p.337 ($E_x$ = 2159 keV), A=75 p.41 ($E_x$ = 822 keV), A=76 p.536 ($E_x$ = 2429 keV).

The same applies to $E_x$; for $^{60}$Cu much better $E_x$ values are given in 69Ho01 than those listed on p.343.

k) No δ-values should be given related to J-values other than those listed in the master table (certainly not without a warning to the reader); example: A=52 p.279 where δ(2038 keV) is given for J(3472 keV) = 2 instead of J = 3.

6. Examples of poor listing of branching ratios.

a) A=51 drawing 8. Because there is no corresponding table, the branching ratios in drawing 8 are useless because the errors are not presented. Yet errors are given in at least part of the source literature (e.g. in 70Sa15).

b) A=55 drawing 18. Identical case. Errors are given in 75Ca36.

c) A=55 drawing 9, right hand part. There is a corresponding table on p.511 but here the $I_\gamma$ column is missing. Branching errors in the drawing are missing, although given in source papers (73Hi02, 73Hi07).

d) A=59 drawing 7 and p.508. Branching errors are missing in both drawing and table although given in 73Hu03.

e) A=65 p.369. Branching ratios are missing in table "Adopted γ-ray properties"!

7. Remarks on section "Gamma Transitions" in "Summary of bases for spin and parity assignments".

a) The term "multipolarity" should be replaced by "character" (Λ). Multipolarity only indicates the orbital angular momentum (L) of the emitted photon, whereas character includes the distinction between E and M.

b) Didactically, half-lives are not a proper measure to classify γ-ray strengths. Taking into account branching and mixing, one would have to calculate the "partial half-life", but this is a confusing conception because the partial half-lives do not add up to the total half-life. The relevant paragraph should be rewritten for γ-ray widths or, still clearer, for γ-ray strengths (expressed in Weisskops units). And, by the way, couldn't NDS be induced to replace half-lives by mean lives, at least for short-lived states? It is almost unavoidable that the reader makes errors in the conversion of one into the other.

There are serious objections against some of the half-life lower limits listed. Some objections are based on my paper "Strengths of γ-ray transitions in A = 6-44 nuclei (III)' to appear in Atomic Data and Nuclear Data Tables", and some on an analogous paper for the A = 45-90 region which is now being typed. They relate to a) the distinction between isovector (IV) and isoscalar (IS) transitions, b) the strength A-dependence for E1, E2 and M1 and M2 transitions.

Point a) is only relevant for A<45; no T-retarded transitions are known at present for A>45 (almost all nuclei in this region have a neutron excess). If NDS would state that their section "Gamma Transitions" is only valid for A>45, it can forget about the IV, IS distinction. If not, the distinction should definitely be made, because for A<45 many $J^{\pi}$ and T-assignments are based on the IV, IS strength differences.

From 1200 transitions in the A = 45-90 region the following recommended upper limits (RUL) for γ-ray strengths have been derived (RUL in W.u.): E1 0.01, E2 300, E3 100, E4 100, M1 3, M2 1, M3 10, M4 30. These agree with the $T_{1/2}$ lower limits in NDS, but for

E2 and M1, where the NDS values are a factor 3.3 less restrictive. For A = 6-44 the NDS values would be inapplicable (45 E1 strengths are known exceeding 0.01 W.u., and 7 M2 transitions with S > 1 W.u.; there are no E2 transitions exceeding 100 W.u., and thus 1000 W.u. is much too high; for $E1_{IS}$, $E2_{IV}$, $M1_{IS}$ and $M2_{IS}$ the RUL's corresponding to the NDS values for transitions without T-retardation are so high as to be useless for spectroscopy).

The paragraph 7 about mixing is vague, incorrect and unnecessary. It is vague because the qualitative "appreciable mixing" leaves too much interpretative leeway to the user. That it is incorrect can be seen by taking the example of E2/M1 mixing. By writing out the ratio of the Weisskopf estimates (for $r_o$ = 1.20 fm) one easily finds $\delta^2(E2/M1) = 2.3 \times 10^{-6} A^{4/3} E_\gamma^2\ S(E2)/S(M1)$, where $E_\gamma$ is in MeV and where S is the strength in W.u. The result that, for fixed S-values, $\delta^2$ depends on A and $E_\gamma$, invalidates the rules of paragraph 7. For the quite reasonable values S(M1) = 0.1 W.u., S(E2) = 10 W.u. there is a large range of values of A and $E_\gamma$ (e.g. A>125, $E_\gamma$ > 2 MeV) which would lead to appreciable mixing ($\delta^2 > 0.6$). The fact that a strong M1(+E2) transition, especially at low $E_\gamma$ (and/or small A), cannot be appreciably mixed is of course extensively used by spectroscopists, but in a quantitative way. For the transition with a width $\Gamma_\gamma$(exp) he would calculate the $\Gamma_\gamma$ corresponding to the E2 RUL to arrive at $\delta^2 < \Gamma_\gamma(\text{RUL E2})/\{\Gamma_\gamma(\text{exp}) - \Gamma_\gamma(\text{RUL E2})\}$.

8. Remaining remarks on specific A-chains.

A=45 p.29. Why favour (in note #) one type of data over another? If the compiler does not take the weighted average he should give an argument.

pp. 47 and 48. Pages $^{45}$Ti-2 and $^{45}$Ti-3 have been interchanged.

A=46 p.26. Why has the compiler calculated the B(E2) for $E_\gamma$ = 52 keV? This $(5,6)^+ \to 4^+$ transition could as well have M1 character.

p.33. a) The note corresponding to the asterisk in $T_{1/2}$(2010 keV) is missing.

b) Instead of hiding most $T_{1/2}$ measurements in the column Comments, the compiler should have had the courage to present his adopted $T_{1/2}$ values (with adopted errors), even if values from different reactions are conflicting.

A=48 p.25 (lower table). The $I_\gamma$ in note for 4284 keV level should be replaced by $I_\pi$.

p.42 (upper table). Note † is attached to nothing.

Ref. list. The important references 75Gu13 and 75Ha03 have not been quoted; they are missing in the ref. list.

A=49 drawing 7 and p.214. The $^{49}Sc(\beta^-)$ decay does not lead to $J^\pi$(1623 keV) = $(5/2-9/2)^-$ but to (5/2-9/2).

pp. 228 and 244. The compiler notes that the ($\alpha$,p$\gamma$) results for $\delta$(1155 keV) from 75Ha12 and 73Sa12 are in agreement; he should have noted also that the ($\alpha$,p$\gamma$) value is in disagreement with the (p,n$\gamma$) value on p.244.

A=51 Ref. list. Ref. 75Be07 is neither listed nor quoted.

A=52 p.269. The verbose note regarding $J^\pi$(3472 keV) is wrong as to the interpretation of the (p,p') work. It should read: "The β-decay of $^{52}V(J^\pi = 3^+)$ and $^{52}Mn^m(J^\pi = 2^+)$ yields the limitation J(3472 keV) = (2,3) (both transitions are either allowed or non-unique first-forbidden). From L(p,p') = 4 (70Pr08) one obtains $J^\pi = (3-5)^+$. Conclusion: $J^\pi = 3^+$."

p.281 lower table. In last line of caption replace 64Be22 by 64Be32.

p.290. In the column Comments, mixing of (unnecessary) weak $J^\pi$ arguments with strong arguments should be avoided. The perfectly reliable $1^+$ assignment for the 546 keV level from $^{52}Fe(\beta^+)$ log ft is weakened by mentioning (d,$\alpha$) and L-values from (p, $^3$He) and ($^3$He,t).

Ref.list. a. Ref. 75To06 is neither listed nor quoted.

b. Ref. 64Be22 is irrelevant for A=52.

A=53 p.343. The B(E2) mentioned for the 1290 keV level belongs to the 564 keV level (see pp. 344 and 349).

pp. 351, 352. Instead of the non-informative $T_{1/2}$ values for $E_x$ = 2407 keV and four other levels, the reader would prefer to get adopted values with adopted errors from the compiler.

Drawing 13 and p. 353. The compiler evidently doubts the existence of the dashed transitions in the drawing but there are no corresponding brackets in the table.

A=54. Ref. 75Ko19 is used nor listed.

A=55 pp.500-502 and 531-535. Waste of space. The compiler should just mention that the information is available in source papers.

p.511. a. The reader expects the B's in column Comments to be derived from $T_{1/2}$ on p.512. This is not true for the 126 keV level where B(E2) results from Coulomb excitation (73Hi02).

b. The reader has to go to drawing 9 to find that $\delta$(1885 keV) relates to J(1885 keV) = 7/2, but this assignment has not been accepted as unambiguous by the compiler (see p.494).

p.513. Change $E_x$ = 941.3 into 931.3 keV.

A=58 p.473 bottom table. The jargon E4/M3 < 0.0002 is ambiguous; might relate to $|\delta|$ or to $\delta^2$.

p.475. For $E_\gamma$ = 321 and 433 keV the E2 percentages in column Mult. are at variance with the $\delta$'s listed in the last column.

pp. 492, 493. The branchings for the 2943 keV level ($E_\gamma$ = 41, 167 and 1488 keV) are not really photon branchings (as stated) because they add up to 73%, instead of 100%. One should either list photon branchings as 73, 13 and 14%, or total branchings as 81, 9 and 10%.

A=59 p.500 upper table. Why didn't the compiler accept the $J^\pi$ assignments from the nice (d,p) and (t,p) work in 72Mc18, e.g. $J^\pi$(574 keV) = $3/2^-$, 1026 keV $7/2^-$, 1081 keV $(1/2,3/2)^-$ etc.; he should at least have given a reason.

p.512. To the 2266 keV level $\pi = -$ should have been assigned from $T_{1/2}$, branchings, and either $\delta$(2266 keV) or $\delta$(1774 keV).

pp. 512 and 514. The 3130 keV level has $T_{1/2} = 7 \pm 3$ fs (not $6.9 \pm 0.3$ fs).

A=60 drawings 5 and 9. Why $^{60}$Cu(EC) decay in fig. captions instead of $\beta^+$ + EC?

p.334. The table caption suggests that one can transfer L-values.

p.335 a. Upper table. Replace $\delta$ by $|\delta|$.

b. Middle and lower tables. Note † is quite funny.

pp. 337, 338, 340 and 349. Ref. 74Si04 does not relate to A=60.

p.338 a. Middle table. The notation 1.36E418 is incomprehensible.

b. Lower table. The reader doesn't understand to which L-value the listed

$\beta(L)$ apply.

p.346 lower table. Compiler should have found out that the listed (large) value of $\alpha$ would lead to an impossibly strong E2 transition of 3000 W.u.; the value (from 69Ho01) is an upper limit, however!

A=61 p.14. The value Q(67 keV) = $-0.20 \pm 0.03$ b from 71Go31 has been omitted in master table.

p.18. With the compiler I loathe "double errors". For $E_\gamma$ = 338 keV he has changed author's value of $1.2^{+0.5}_{-0.9}$ into $1.0 \pm 0.7$; personally I would prefer $1.2 \pm 0.7$. Matter of taste.

A=62 (1979) p.30. The only valid argument for $J^\pi$(2891 keV) is L(t,p) = 0; the absence of $\gamma$- and/or $\beta$-transitions should not even be mentioned in a compilation.

p.32. Omit $\delta$ and replace M1 + E2 by E2 for the 1718 keV $0^+ \rightarrow 2^+$ transition from the 2891 keV level.

A=63 p.139, 1412 and 1547 keV levels. The reader has to look up 68Al13 to learn that W represents an unspecified angular distribution at an unspecified angle; not very informative.

p.142. Also listed under Reaction Gamma's should have been $\delta(190\gamma) = +0.06 \pm 0.02$ from 68Bi03.

A=65 p.362 upper table. a. In note †, why mix in the (unnecessary) weak argument (shell model) between two strong arguments (L and log ft)?

b. The $1/2^-$ assignment for the 64 keV level (based on note ‡) is not correct; should be $(1/2,3/2)^-$. In the note first L(d,p) = 1 should have been mentioned; the (d,p) J-dependence is irrelevant (weak argument). The E2 character of the 64 keV transition does not necessarily imply that the transition proceeds between states with $|J_i - J_f| = 2$; should be $|\vec{J}_i - \vec{J}_f| = 2$.

p.364 upper table. The $J^\pi$ discussion is incomplete and, in several places, erroneous. Examples: Note †. Why $\pi$ = − for ground state?

Note ‡. The J-dependence leads, at best, to $J^\pi$(771 keV) = $(1/2)^-$.

p.368. The $J^{\pi}$(54 keV) = $1/2^-$ assignment is unjustified, on the same grounds as for $^{65}$Ni(64 keV) (see above).

p.369. For $E_\gamma$ = 61 keV, replace $\delta < 0.24$ by $|\delta| < 0.24$.

A=66 drawing 5. The $J^{\pi}$ values resulting from $^{66}$Ga($\beta^+$ + EC) log ft values are lacking.

p.402. For several levels it is unclear which $\Gamma_o/\Gamma$ values have been used to derive the $T_{1/2}$ listed. The primary information $g\Gamma_0^2/\Gamma$ should also have been presented.

p.404. The $T_{1/2}$(44 keV) values of 12 ± 1 ns and 21 ± 2 ns in 69Ba31 and 69Bo21, both from delayed coincidence $^{66}$Ge($\beta^+\gamma$) measurements, should have been mentioned and should have been used in the adopted value.

A=68 p. 169. The error in $T_{1/2}$(2751 keV) is lacking (see p.180 lower table).

A=71 p.215. a) The J-values for $E_x$=0, 675 and 853 keV should have brackets.

b) For $E_x$ = 285 keV replace 3/2,5/2 by $(3/2,5/2)^+$.

A=72 drawing 8. The reader should have been warned that the E($\beta^+$) (with keV precision!) and log ft values are based on a Q-value of ≈9000 keV from systematics (p.136); the compiler should not have presented them.

p.134 upper table. The two excited-state $T_{1/2}$ values have dropped one line.

p.135 master table $^{72}$Se. The $J^{\pi}$ assignments for $E_x$ = 862 and 1317 keV and the parities for $E_x$ = 1637 and 2469 keV should be unbracketed. The arguments "no g.s. γ" and "no other γ's" should disappear; for the 3428 keV level the argument "959γ is E2" should disappear (α has not been measured).

p.149, $T_{1/2}$ (691.2 level). In last line change ns into μs.

p.150. The B(E1)↑ from $^{72}$Ge(p,p')(θ) are misleading; should be B(EL)↑ expressed in s.p. units. Actually, they shouldn't have been listed at all, because these B(EL)'s from (p,p') are quite model dependent.

A=74 p.539 upper table. The $J^{\pi}$ argument for $E_x$ = 56.5 keV should disappear. The parities for $E_x$ = 0 and 56.5 keV should also disappear (or, at best, be bracketed).

p.543. For $E_x$ = 1204 keV, the δ(608 keV) does not figure in the derivation of $T_{1/2}$ from B(E2↑).

A=75 p.47. The $J^{\pi}$ value of $^{75}$Br(0) is unambiguously determined as $3/2^-$ from $^{75}$Br β-decay;

this leads to $\pi = +$ for $E_x = 133$ keV from $\alpha(133\gamma)$ (see p.48).

A=76 p.538. In 1st line change $^{75}$As into $^{76}$As.

p.542. References are lacking for $^{76}$(Se(n,n'$\gamma$).

A=78 pp. 127, 131. The errors in $I_{ceK}$ from 73Wy01 are not absolute but percentage errors.

A=80 p.303. For 1450 keV level replace $\varepsilon(782) = 0.44 \pm 0.08$ by $0.44 \pm 0.06$; replace $\varepsilon(1450) = 0.55$ by 0.56.

A=81 p.150 upper table. Replace $T_{1/2}$(538 keV) = $0.60 \pm 0.03$ ps by $0.60 \pm 0.13$ ps (see p.160).

A=84 (1979) p.365. For the 882 keV $2^+ \rightarrow 0^+$ transition the brackets around E2 in the column Mult. are incomprehensible.

pp. 371, 373, 374. The discussion concerning the $J^\pi$ value of the 248 keV level and the character ($\Lambda$) of the 216, 248 and 464 keV $\gamma$-rays is of extreme verbosity.

The $E_\gamma = 464$ keV $6^- \rightarrow 2^-$ transition can only have almost pure E4 character; even a mixing ratio as small as $|\delta| = 0.001$ would lead to an impossibly strong M5 admixture.

Why talk about other $\Lambda$-values? Why talk about the old and indirect $\alpha$-measurement which evidently must be wrong?

As to $J^\pi$(248 keV), the $\ell$(p,d) = 4 value, the widths of the 248 and 216 keV transitions, and $\alpha$(216 keV) lead to $J^\pi = (3,4)^-$. Why mention weak arguments like the shell model or the fact that, for E2 character, the HF(216 keV) is large?

Utrecht, December 1979.

## Comments on "General Remarks on Format and Presentation of Nuclear Data Sheets" by W.B. Ewbank

I. There seem to be three general areas where our experience has been different from yours: we have developed different understandings of the words "compilation, evaluation, review" and how they apply to our work; we have developed a different view of the importance of gamma-ray properties; and we have considered some computer capabilities when making decisions about which of two (equivalent) kinds of data to include in ENSDF. I believe that the kind of information you want to study or present in detail can be and should be contained in ENSDF. It seems important, then, to focus on a step-by-step movement from the framework already designed for ENSDF toward the more complete, more uniform data base we all would like to see.

A. In the matter of definitions: I consider a compilation to be a simple collection of available values, with no attempt made to choose which are better or worse, and certainly no conclusions about what constitutes a "reasonable" set of parameters from all available evidence. In the 1950's when measurements were few, this was a valuable activity. Some of the early publications of the Nuclear Data Group were compilations, which were welcomed by the field as a contribution toward organizing what we knew about nuclei and helping to establish standards for reporting new nuclear measurements. Beginning in the early to mid-60's, choices among measurements began to appear. The term "adopted value" was chosen to represent the conclusion from an evaluation of several related measurements. In the present system, an entire ENSDF data set is devoted to only these "adopted values," so that a single block of numbers should summarize all that is established about the levels of one nucleus. All the numbers here should be "traceable." An ENSDF user should be able to reproduce the arguments used to obtain an adopted value, even though the individual measured values may not be included explicitly. The present Nuclear Data Sheets (and ENSDF as well) represent an evaluation, rather than a compilation, since explicit choices are made from among available measurements. I do not consider the Nuclear Data Sheets to be a critical review, because there is not sufficient time to carry out in-depth studies of so many different topics. On the other hand, the work of evaluation can lead to preparation of critical reviews. Examples are your review of gamma-ray strengths, and the systematics of heavy-element configurations by Ellis and Schmorak. Certainly no critical review should be done without considering existing evaluations.

B. In many light nuclei, individual levels have often been studied extensively. Frequently the energy between levels is large and configurations are sufficiently different that each level can be identified unambiguously. In heavier nuclei, level density is greater, and the very existence of a level is often based on a suggested gamma-ray placement. Few level energies are measured directly, but they can always be obtained from the measured gamma-energies as soon as a placement is assumed.

Assignment of uncertainties to level energies is easy if the gamma-ray energies are available, but realistic uncertainties can not be assigned to gamma-ray energies derived from level energies unless the correlations between level energies are also known. Usually these correlations are exactly described by the uncertainties on the gamma-ray energies, themselves. If a computer file includes gamma-ray energies and uncertainties, a computer can be asked to produce level energies and uncertainties almost as easily as it can retrieve the gamma-ray data. If the computer file includes only level energies and uncertainties, there is no way to prepare correct gamma-ray energies with uncertainties.

C. The intensity given for "branching" from a level could indeed be normalized to 100%. If all branches have been measured (including particle decay) and all internal conversion coefficients are known (or can be neglected), this "absolute photon branching" will give the lifetime for the electromagnetic transition most directly. If conversion is important, the photon fractions will not sum to 100%, and the difference from 100% will depend on the detailed assumptions about the conversion coefficients. Displaying a set of intensities which may or may not sum to 100% is no more reassuring to me, as a user, than to see any other set of relative numbers.

In many cases, different experiments have led to the assignment of different numbers of gamma-rays to the same nuclear level. If a new measurement establishes three gamma-rays depopulating a level, where older experiments saw only two, an absolute normalization would require renormalizing all the older measurements before direct comparison of stated intensities could be made. This extra work can be avoided if an arbitrary value, such as 100, is assigned to the intensity of the strongest gamma-ray, since it will usually appear in even the earliest measurements.

In the computer environment, calculation of absolute transition probabilities is almost as easy from relative branching as from absolute branching. Furthermore, the calculation can be done in a more systematic way than would be the case if absolute intensities had been originally entered into the computer file (perhaps by several different people).

II. As stated above, I believe that ENSDF provides a reasonable framework within which most properties of nuclear levels or pairs of levels can be contained. Properties or processes involving three or more levels (e.g., $\gamma\gamma$-angular correlations, multilevel configuration assignments) have been added ad-hoc, with varying success. Questions about what should be published and how it should be arranged in Nuclear Data Sheets are slightly related to ENSDF structure, but can be treated almost independently. Both subjects should be under constant review by the evaluator community, who are one of the most intensive user groups.

A. Real and potential problems with ENSDF fall naturally into three categories:

1. The structure of the file may need modification to allow inclusion of more or different data elements.

2. The minimum requirements for a data set acceptable to ENSDF will become more narrowly defined as time passes.

3. Procedures for review and criticism of data set contents must become tighter, perhaps by introducing more detailed computer checking of completeness and consistency.

At present, the basic ENSDF file structure has been defined by ORNL/NDP. We have described minimum requirements for ENSDF data sets, based on our own needs and desires to use the file for scientific purposes and to answer requests for special data collections. We have tried to enforce the minimum standards with a combination of computer checking and multiple review, at ORNL and elsewhere.

In the future, there will be less autonomy for any single center, and the responsibility for overall content and consistency of the data file will become more diffuse. In this environment, procedures to ensure reasonably uniform quality for the data file will become very important. More explicit guidance for individual evaluators will evolve in order that numbers from different mass regions can be used with equal confidence and understanding. More computer checking of data sets will be needed, so that reviewers can concentrate on judgment decisions of physics rather than on the more mechanical questions of whether or not all the requirements have been met.

B. Three questions dominate consideration of what Nuclear Data Sheets or a successor publication should include.

1. Who is the principal audience for the publication? A single publication may not even be adequate for all the diverse users of ENSDF data. Gamma-ray tables are an example. We have always listed them in order of gamma-ray energy so that the experimentalist could compare easily with a measured spectrum. When we move into interpretation of a level scheme, the ordering by levels is more reasonable. (For this purpose, both initial and final level properties also need to be shown, however.) Our NDSLIST program (which sets up the tables) can prepare many combinations of gamma-ray and level properties. Perhaps one collection could be published for one user and a different organization of the same data could be prepared for another user. In either case, a uniform presentation in each publication is essential so that every user knows what can be found and what cannot be found in the form he would like.

2. Although ENSDF contains a fairly comprehensive collection of evaluated nuclear data, it is not clear that all of the information needs to be printed in Nuclear Data Sheets for widespread distribution. Detailed conversion-electron data may fall into this category, since they can often be summarized by multipolarity and mixing ratio based on a fairly well-established theory. Angular correlation data may also be adequately summarized by gamma-ray multipolarities and some references to the most recent high-quality measurements (perhaps through the indexed file of Recent References). Choices of which nuclear parameters to display in glorious detail would also be influenced by the target user group.

3. If any publication is to be useful, its contents must be clearly and systematically displayed. I believe that some of the traditional ways of displaying nuclear data are breaking down under the strain of voluminous measurements. For example, the gamma-ray branching is poorly represented by a standard drawing whenever there are more than 20 to 30 gamma-rays. I lean toward using tables more extensively for details and to the design of something even more qualitative to replace the traditional level-scheme drawing. Some users might prefer different compromises; e.g., level schemes with only strongest transitions, or only transitions among specific groups of levels, such as the yrast levels or members or rotational bands. Again, perhaps, the qualitative features could be displayed in publications quite different from the handbook type that is needed for detailed reference.

<u>C.</u> The choices among alternatives for publication, as well as for data file content and control, should now be made through the international network, rather than by individual centers acting more or less independently. Accordingly, fairly detailed specifications must be developed to guide individual evaluators in their work and also to define the kind of computer support that will be needed for the desired information systems.

I have based development of the present system on 1) the ENSDF manual [ORNL-5054], 2) a statement of minimum standards for data sets, and 3) a fairly clear understanding of what should be contained in Nuclear Data Sheets. The replacement system which is now to be developed could profit from a similar set of guidelines, extended and further refined in the direction implied by your "General Comments." Some of our decisions about <u>how</u> data are presented have been influenced by computer coordination, but the choices of <u>which</u> data to display have determined the way the computer must operate. I recommend this approach.

Appendix 25

MEMORANDUM

FROM: V.S. Shirley and C.M. Lederer

TO: Network Members

SUBJECT: Policies for quotation of nuclear moments and spins

The existence of an up-to-date horizontal compilation[1] and the special nature of the evaluation problems make it advisable for ENSDF evaluators to quote nuclear magnetic and quadrupole moments from that source, rather than re-evaluate them from original papers. This memo contains our recommendations on the compilation of moments and directly measured nuclear spins.

I. How to list nuclear moments in ENSDF

A. Where to list moments

Adopted moments for ground and excited states should appear in the adopted levels data set. The inclusion of moments measured in individual reactions in the corresponding data sets is unnecessary, can be time-consuming, and is subject to evaluation errors if the evaluator is not familiar with the field. It is not recommended.

B. How to list moments

All magnetic moments in ENSDF should be corrected for diamagnetic shielding, if applicable (i.e., if external magnetic fields were used in their determination. If internal (hyperfine) fields were used, no corrections should be made.) The correction factors given in Table 1 are widely accepted, and should be used when evaluating new $\mu$ values. Quadrupole moments should be listed with polarization ("Sternheimer") correction if given that way. The following information should be included with the moment entries.

1. A note of all corrections included (other than the diamagnetic shielding corrections) and their values, if known.
2. The method of measurement (see Table 2).
3. A reference to 78LEZA and/or other sources, if new or additional information was used by the evaluator.
4. Other comments as appropriate. See especially Tables 2 and 3 and section II below.

Examples:

```
115CD  L 0.0          1/2......
115CD2 L MOMM1=-0.648425 1, OPTICAL PUMPING, NMR (78LEZA)

193IR  L 73.012      7 1/2......
193IR2 L MOMM1=+0.504 3 (INCLUDES +1.3 4% KNIGHT SHIFT CORR.),
193IR3 L MOSSBAUER (78LEZA)
```

## II. Evaluation policies for nuclear moments

### A. Sources of information

1. Use the *Table of Nuclear Moments*[1] as a base reference for magnetic dipole and electric quadrupole moments reported through December, 1977.

2. Use reference 2 (76Fu06) for octupole and hexadecapole moments reported through about 1973.

3. Check the reference list to determine if there are more recent papers reporting experimental values or recalculated ones.

B. Recommended procedures for adopting and quoting values from reference 1 are summarized in the attachment.

C. New measurements (not included in the *Table of Nuclear Moments*[1]) may require additional evaluation. The evaluator should be aware of the kinds of problems noted elsewhere in this memo and the attachment. The following points are especially important:

1. There is no general method to look up or compute corrections other than the diamagnetic correction. The author's diamagnetic correction should be checked (and revised if necessary) to make sure that the value in Table 1 is used. The best policy for other corrections is almost always to quote the author's own corrected value and note the correction factor in a comment.

2. Beware of apparent discrepancies between "incomparable", method-dependent values. In particular, "direct" methods such as AB/D and OP are usually preferable to NMR values with which they disagree, even when the latter are more precise.

3. A new value based on a reported "calibration" moment or given as a ratio of g-factors or moments should be calculated from the "recommended" value for the standard. (See the attachment). It is important for the evaluator to be aware of other moments that may change as a result of a new value, by checking the adjacent rows of the *Table of Nuclear Moments* [1] (for intra-element standards, in square brackets), or Table 4 (for inter-element standards). We should be consulted if evaluators feel any revision of a standard is required.

D. Assistance with the evaluation of new measurements will be provided by the Isotopes Project if requested by the evaluator. We are planning to maintain the *Table of Nuclear Moments* on a 3- or 4-year cycle. The next edition will include explicit adopted values and values of correction factors used. It will also include higher-order moments.

## III. Directly measured nuclear spins

### A. How to obtain and quote directly measured spins

The 7th edition of the *Table of Isotopes* (78LEZA) is the most up-to-date source for directly measured spins; it includes all pertinent

Table 1

Diamagnetic correction factors

| Z | $1/(1-\sigma)$ | Z | $1/(1-\sigma)$ | Z | $1/(1-\sigma)$ | Z | $1/(1-\sigma)$ | Z | $1/(1-\sigma)$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00002579 | 21 | 1.001603 | 41 | 1.004456 | 61 | 1.008897 | 81 | 1.0166 |
| 2 | 1.00005994 | 22 | 1.001716 | 42 | 1.004633 | 62 | 1.009188 | 82 | 1.0172 |
| 3 | 1.0001048 | 23 | 1.001834 | 43 | 1.004815 | 63 | 1.009487 | 83 | 1.0177 |
| 4 | 1.0001531 | 24 | 1.001956 | 44 | 1.005000 | 64 | 1.009789 | 84 | 1.0183 |
| 5 | 1.0002068 | 25 | 1.002077 | 45 | 1.005194 | 65 | 1.0101 | 85 | 1.0189 |
| 6 | 1.0002672 | 26 | 1.002203 | 46 | 1.005389 | 66 | 1.0104 | 86 | 1.0195 |
| 7 | 1.0003332 | 27 | 1.002332 | 47 | 1.005586 | 67 | 1.0108 | 87 | 1.0202 |
| 8 | 1.0004059 | 28 | 1.002468 | 48 | 1.005788 | 68 | 1.0111 | 88 | 1.0208 |
| 9 | 1.0004844 | 29 | 1.002611 | 49 | 1.005994 | 69 | 1.0115 | 89 | 1.0215 |
| 10 | 1.0005693 | 30 | 1.002749 | 50 | 1.006203 | 70 | 1.0118 | 90 | 1.0222 |
| 11 | 1.0006495 | 31 | 1.002899 | 51 | 1.006419 | 71 | 1.0122 | 91 | 1.023 |
| 12 | 1.0007322 | 32 | 1.003031 | 52 | 1.006639 | 72 | 1.0126 | 92 | 1.024 |
| 13 | 1.0008172 | 33 | 1.003177 | 53 | 1.006861 | 73 | 1.0130 | 93 | 1.024 |
| 14 | 1.0009056 | 34 | 1.003327 | 54 | 1.007092 | 74 | 1.0134 | 94 | 1.025 |
| 15 | 1.0009975 | 35 | 1.003479 | 55 | 1.007325 | 75 | 1.0138 | 95 | 1.026 |
| 16 | 1.001093 | 36 | 1.003635 | 56 | 1.007564 | 76 | 1.0143 | 96 | 1.027 |
| 17 | 1.001191 | 37 | 1.003790 | 57 | 1.007811 | 77 | 1.0147 | 97 | 1.028 |
| 18 | 1.001294 | 38 | 1.003950 | 58 | 1.008075 | 78 | 1.0152 | 98 | 1.029 |
| 19 | 1.001394 | 39 | 1.004114 | 59 | 1.008341 | 79 | 1.0157 | 99 | 1.029 |
| 20 | 1.001495 | 40 | 1.004282 | 60 | 1.008616 | 80 | 1.0161 | 100 | 1.030 |

Table 2

| Methods in the *Table of Nuclear Moments* | | Recommended for ENSDF |
|---|---|---|
| Code | Description | |
| AB | Atomic beam magnetic resonance (hyperfine structure) | Atomic beam |
| AB/D | Atomic beam magnetic resonance (direct moment determination) | Atomic beam (direct) |
| AB/LF | Atomic beam magnetic resonance (laser-fluorescence technique) | Atomic beam (laser fluor.) |
| CDPAC | Constant-delay perturbed angular correlations | Constant delay PAC |
| CEAD | Integral perturbed angular distribution of $\gamma$ rays following Coulomb excitation | Coul. ex. IPAD |
| CER | Coulomb-excitation reorientation effect | Coul. ex. reorient. |
| CERP | Coulomb-excitation reorientation, precession technique | Coul. ex. reorient. precession |
| CETD | Time-differential perturbed angular distribution of $\gamma$ rays following Coulomb excitation | Coul. ex. DPAD |
| DPAC | Differential perturbed angular correlations | DPAC |
| DPAD | Differential perturbed angular distribution of $\gamma$ rays following nuclear reactions | DPAD |
| ENDOR | Electron-nuclear double resonance | ENDOR |
| EPR | Electron paramagnetic resonance | EPR |
| ES | Electron scattering | Electron scattering |
| FDPAC | Differential perturbed angular correlations (using aligned fission fragments) | Fission DPAC |

references from 76Fu06[2], plus more recent data. (Spins are given within the tabular listings in the main table, under the heading "I:".) ENSDF evaluators should report the method of measurement and the original reference on a comment (CL J) card. (See Table 2 for abbreviations of the methods.) Note that, in the case of multiple determinations, the methods and references are grouped separately in the *Table of Isotopes*; when they agree in number, one can safely infer that the first reference goes with the first method, the second with the second, etc. When there are more references than methods (or vice versa), the evaluator must refer to 76Fu06 or to the original papers to sort them out.

B. Evaluation policy for directly measured spins

We believe that all spin assignments in 78LEZA based on direct measurements are certain. Although such assignments are normally considered "foolproof", there have been a few incorrect ones in the past. In comparing a directly measured spin with an assignment determined from nuclear spectroscopic considerations, we recommend that the direct determination should be accorded the same weight as a very good spectroscopic value, rather than an automatic endorsement.

References:

1. *Table of Nuclear Moments*; Appendix VII in the *Table of Isotopes*, 7th edition (78LEZA; see Nuclear Wallet Cards for complete citation).
2. Gladys H. Fuller, J. Phys. Chem. Ref. Data 5, 835 (1976). (76Fu06)

| Methods in the *Table of Nuclear Moments* Code | Description | Recommended for ENSDF |
|---|---|---|
| IMPAC | Ion implantation perturbed angular correlations | IMPAC |
| IPAC | Integral perturbed angular correlations | IPAC |
| IPAD | Integral perturbed angular distribution of $\gamma$ rays following nuclear reactions | IPAD |
| MA | Microwave absorption in gases | Microwave abs. |
| MB | Molecular (or diamagnetic atomic) beam magnetic resonance | Molecular beam |
| ME | Mössbauer effect | Mossbauer |
| MH | Meson hyperfine structure | Meson hfs |
| M/N | Maser/nuclear magnetic resonance frequency comparison | Maser/NMR |
| N | Nuclear magnetic resonance | NMR |
| N/ME | Mössbauer-effect detection of nuclear magnetic resonance | NMR/Mossbauer |
| NO/D | Dynamic nuclear orientation | Nucl. orient. (dynamic) |
| N/OP | Free-atom nuclear magnetic resonance observation via resonant charge exchange with optically pumped ions | NMR/optical pumping |
| NO/S | Static (low-temperature) nuclear orientation | Nucl. orient. |
| N/RD | Radiative detection of nuclear magnetic resonance | NMR/rad. detection |
| NRES | Neutron resonance energy shift | Neutron res. energy shift |
| NRF | Nuclear resonance fluorescence (integral angular distribution measurement) | Nucl. res. fluor. IAD |
| O | Optical spectroscopy | Optical spectr. |
| OD | Optical double resonance | Optical double res. |
| OL | Optical level crossing | Optical level crossing |
| OP | Optical pumping | Optical pumping |
| OP/RD | Radiative detection of optical pumping | Optical pumping/rad. detection |
| PPDAC | Perturbed polarization-directional angular correlations | Perturbed polariz. dir. AC |
| PPR | Proton pickup reactions; calculated from spectroscopic factors [see Nucl. Phys. A213, 493 (1973)] | Proton pickup reactions |
| Q | Quadrupole resonance | Quad. res. |
| QIR | Quadrupole interaction observed by relaxation time measurements | Quad. relaxation |
| R | Recalculation (or new calculation) based on experimentally determined parameters | Recalc. |
| RIGV | Recoil into gas and/or vacuum | Recoil into gas/vacuum |
| RIV/D | Recoil into vacuum, differential technique | Recoil into vacuum (differential) |
| SOPAD | Stroboscopic observation of perturbed angular distributions | Stroboscopic PAD |

Table 3

| Footnotes in the *Table of Nuclear Moments* | | Recommended for ENSDF |
|---|---|---|
| a | Reported as published by the original authors. Corrections, as described in the introduction, were not made because the authors made their own correction analysis (often including other effects). | * |
| b | Lifetime-dependent value recalculated for consistency with the listed half-life. | (Recalc. for consistency with adopted $t_{1/2}$) |
| c | Lifetime-dependent value not necessarily consistent with the listed half-life. (Adequate information was not reported.) | (Not necessarily consistent with adopted $t_{1/2}$) |
| d | Subject to a hyperfine anomaly correction. | * |
| e | Calculated with the use of a hyperfine-structure ratio and the magnetic moment value of the listed standard. No additional error allowance was made for hyperfine-structure-anomaly effects. | * |
| f | Calculated with the use of a moment ratio and the magnetic or quadrupole moment value of the listed standard. | |
| g | Calculated from a reported value of $g_I$ and the values of the Bohr and nuclear magnetons in J. Phys. Chem. Ref. Data 2, 663 (1973). | |
| h | Does not include a Knight-shift correction. | * |
| i | Recalculated for consistency with the listed standard. | |
| j | $\mu/Q > 0$ (Signs of $\mu$ and Q are the same). | ($\mu/Q>0$) |
| k | $\mu/Q < 0$ (Signs of $\mu$ and Q are different). | ($\mu/Q<0$) |
| l | Includes estimated Knight-shift correction. | * |
| m | g-factors for ground-state band are approximately constant for levels with spins up to and including I=8. | (Same, in parentheses) |
| n | No experimental details available. | (Author's reported value. No details available) |
| p | Average value for "prerotational" states above listed energy. Half-life value is an approximate estimate based on theory. | (Same, in parentheses) |
| q | Recalculated for consistency with the listed (newly-reported) spin value. | (Recalc. for consistency with adopted J) |
| r | Relative positions of isomers unknown. | |
| st | "Sternheimer" or other polarization correction included. | (Includes polariz. corr.) |

| Footnotes in the *Table of Nuclear Moments* | Recommended for ENSDF |
|---|---|
| t Measurement involved direct nuclear interaction leading to true quadrupole moment. | (Polariz. corr. not required) |
| u No polarization correction included. | (Does not include polariz. corr.) |
| v More than one value reported because of differing experimental conditions. | |

---

* Evaluator should review the original paper and extract information on corrections included, or estimated uncertainties due to the omission of applicable corrections.

Table 4

Isotopes (or levels), whose first listed moment values in the *Table of Nuclear Moments* are considered "standards".

| For magnetic moments | | For quadrupole moments |
|---|---|---|
| $^{1}H$ | $^{39}K$ | $^{111}Cd$-245 |
| $^{2}H$ | $^{45}Sc$ | $^{115}In$ |
| $^{7}Li$ | $^{87}Rb$ | $^{117}In$-660 |
| $^{8}Li$ | $^{104}Ru$-358 | $^{121}Sb$ |
| $^{11}B$ | $^{110}Pd$-374 | $^{127}I$ |
| $^{14}N$ | $^{111}Cd$ | $^{129}I$ |
| $^{17}O$ | $^{115}Sn$-714 | $^{139}La$ |
| $^{19}F$-197 | $^{199}Hg$ | $^{140}Ce$-2084 |
| $^{23}Na$ | $^{212}Rn$-1671 | $^{241}Am$ |
| $^{35}Cl$ | $^{239}Pu$ | |
| $^{37}Cl$ | $^{241}Am$ | |

Attachment

Recommended Procedures for Adopting and Quoting Nuclear Moments from the *Table of Nuclear Moments*

Value of the moment

Case 1. Single value quoted: use value.

Case 2. More than one value quoted with different methods of measurement indicated: use first-listed value; it is a more reliable estimate of the true moment. The other values can be included in a subsequent comment if the evaluator feels they are of interest to users.

Case 3. More than one value quoted with the same method of measurement:

a) If the values disagree, use the first value and add a strong comment pointing out the disagreement (including disagreement in the sign determination). Other values should be included in the comment.

b) If the values agree, use the first or, if the reported uncertainties are comparable, use an average. (An average may not be appropriate when complex corrections are involved; see below.) Other values can be noted in the comment.

Sign of the moment

All signs are given explicitly in the *Table of Nuclear Moments*; the absence of a sign implies that it was not determined in the measurement. Signs should be adopted from the 2nd, 3rd, etc. listed value, if not given with the first. (See, for example, the magnetic moment for the 91-keV level of $^{147}$Pm.) The method for the sign determination should be added to the method for the first-listed value in such a case.

Dependence on the spin and half-life of the level

Be sure to check your adopted spin assignment and level half-life against the value in the *Table of Nuclear Moments*. Make appropriate corrections to the moments for any change:

1. All methods except NO/S determine g-factors rather than magnetic moments. Thus, if the spin assignment has changed, the correct moment is simply $\mu_{new}=\mu_{old} \times J_{new}/J_{old}$. If the method is NO/S, $\mu_{new} = \mu_{old}$.

2. Moments measured by the following methods are $t_{1/2}$ dependent, and need to be revised if the evaluator's adopted $t_{1/2}$ is new or different: CEAD*, CER, IMPAC, IPAC*, IPAD*, NRF*, PPDAC, and RIGV. Those followed by a * involve a simple inverse relationship between $\mu$ and $t_{1/2}$: $\mu_{new}=\mu_{old} \times t_{1/2 old}/t_{1/2\ new}$. The others involve more complex relationships, which the evaluator will have to work out from the original references.

Method of measurement

Column 3 of Table 2 gives recommended forms for quoting methods. They are less cryptic than the equivalents used for the *Table of Nuclear Moments*, except that we adopted some widely used abbreviations, such as NMR.

A note of caution should be included when NMR values are quoted. (These are listed first in the moments table only when no precise, direct determinations of μ exist.) The NMR values, in spite of the great precision with which they are measured, are often in error due to substantial chemical effects. A sample ENSDF entry for the ground state of $^{41}$Ca would be:

```
41CA    L 0.0.......
41CA 2 L MOMM1=-1.594780 9 (SUBJECT TO CORRECTION FOR CHEMICAL
41CA 3 L EFFECTS), NMR (78LEZA)
```

Footnotes

Appropriate handling of footnotes to the *Table of Nuclear Moments* for ENSDF is indicated in Table 3. Where hyperfine anomaly considerations or Knight shifts are involved (footnotes d,e,h, and l), evaluators should consult the original references and extract whatever information they feel users of the Data Sheets ought to have along with the quoted moment. The same applies to measurements with the footnote a, which indicates that the authors made a complex analysis of corrections, not easily handled by our footnotes. The Knight shift correction is especially tricky; unlike the exactly calculable diamagnetic correction, it is dependent on the experimental variables of temperature, host-impurity combination, and impurity concentration. We recommend a cautious policy of quoting and commenting, rather than revising, averaging, or otherwise "adopting", whenever these more complex corrections are involved.

Standards

The square bracketed "standards", used in the *Table of Nuclear Moments* to indicate that a moment value is related to the first listed value for a "standard" or "reference" isotope or level, are not important for inclusion in the Data Sheets. However, they are very important for evaluators to bear in mind when extracting values of moments from new papers. See Section II-C-3 in the memo for further details.

# SYSTEMATICS OF LOG FT VALUES IN β-DECAY+

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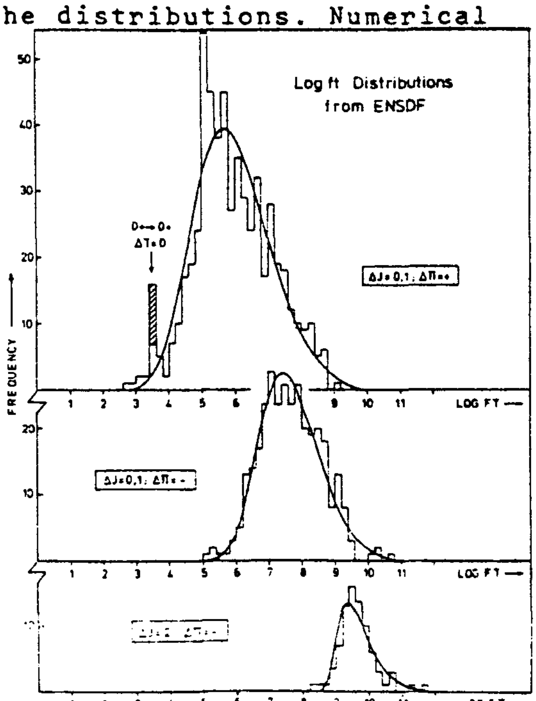
Since the last systematic study of log ft values in beta decay for use in the assignment of spins and parities to nuclear levels appeared several years ago[1]), a wealth of new experimental information has become available, justifying a reexamination of the currently accepted rules. We have extracted over 1400 log ft values between states of known spin and parity from the Evaluated Nuclear Structure Data File (ENSDF) and classified these according to their degrees of forbiddenness. From these values we rejected (1) transitions for which the Jπ involved were deduced from log ft arguments, (2) transitions for which the level feeding was known to less than 50% precision, and (3) very weak transitions with a feeding of less than 0.1%, since the latter were often found to be unreliable. Since the log ft distributions in the strongly deformed rare earth region, and in particular for the even-mass nuclei, differed considerably from those in the non-deformed regions, the even-mass nuclei with A=152-182 were excluded from the present analysis. The resulting log ft distributions are shown in fig.1. Chi-square type curves were fitted to the distributions by scaling and comparison of calculated and observed 3rd moments (skewness) of the distributions. Numerical results are given in Table 1.

Table 1

| Transition (ΔJπ) | 0,1+ | 0,1- | 2- |
|---|---|---|---|
| Number of logft values | 564 | 325 | 77 |
| Degrees of freedom | 30 | 30 | 7 |
| Mean | 6.0 | 7.7 | 9.6§ |
| σ | 1.2 | 0.9 | 0.6§ |
| 5% limit | 4.2 | 6.3 | 8.9§ |
| 50% limit | 5.9 | 7.6 | 9.8§ |
| 95% limit | 8.1 | 9.3 | 10.7§ |

§log $f_1t$ values




No significant violations of the existing rules were found in this study. Despite the presence of various hindering mechanisms it has been demonstrated that log ft values belonging to certain categories of forbiddenness group together in reasonably narrow intervals.

1.S.Raman and N.B.Gove, Phys.Rev. C7 (1973) 1995

+ Supported by the Bundesministerium für Forschung und Technologie

# Arguments for Isobaric Spin Assignments

(A proposal to the NSDD-Network)

P.M. Endt, C. van der Leun

## Strong Arguments

### 1. Spin and parity

Members of a T-multiplet (analogues) have the same $J^{\pi}$ value.

### 2. Energy

The energies of members of a T-multiplet obey the isobaric mass equation $E = a + bT_z + cT_z^2$, where $T_z$ is the z-component of T ($t_z = +1/2$ for the neutron).

### 3. Gamma-decay

a. Gamma-transitions have $\Delta T < 2$.

b. The RUL's for $E1_{IS}$, $M1_{IS}$, $E2_{IV}$ and $M2_{IS}$ transitions (IS = isoscalar, IV = isovector) may be used to limit $\Delta T$.

### 4. Beta-decay

For beta-transitions between analogue states, the Fermi matrix element is given by $M_F = [T(T+1) - T_{iz}T_{fz}]^{1/2}$, where $T_{iz}$ and $T_{fz}$ indicate $T_z$ for the initial and final nucleus. This implies for instance log ft $\leq$ 3.79 for transitions between mirror nuclei, log ft = 3.49 for transitions between $J^{\pi} = 0^+$, T = 1 states, and log ft $\leq$ 3.49 for transitions between T = 1 states with $J \neq 0$.

### 5. Particle decay

In the particle decay $A \to B + b$ the vector addition rule $\vec{T}_A = \vec{T}_B + \vec{T}_b$ should be obeyed.

6. Transfer reactions

a. Single-nucleon transfer

Neutron and proton stripping reactions on the same target nucleus yield the same spectroscopic factors for transitions to analogue final states. The same rule holds for pick-up reactions. For unbound final states the spectroscopic factor may be calculated from the measured nucleon width.

b. Two-nucleon transfer

For transitions to analogue final states, the (p,t) and (p,$\tau$) reactions on the same target nucleus have equal angular distributions. The cross-section ratio is determined by the ratio of the squares of the isospin Clebsch-Gordan coefficients.

## Remarks

It should be kept in mind that isospin is not necessarily always a good quantum number; $T_>$ and $T_<$ states may mix or, in other words, analogue states may be split.

In addition to the strong rules given above, two weak rules of thumb exist which are useful for locating analogue states but not for unambiguous T-determinations.

First one can say that the energy differences between analogue states should be approximately equal to those between the parent states. As an example, corresponding states in mirror nuclei should have approximately equal excitation energies. Observed energy shifts are listed for A = 21-44 in the last table of each A-chain; see Nucl. Phys. A310 (1978) 1.

Second, one may say that analogue states have relatively simple shell-model configurations and thus may be excited relatively strongly in all sorts of transfer reactions.

The strong rules 3-5 given above might be clarified by some examples.

3a. The $\gamma$-emission from the lowest $0^+$, T = 2 state in $^{32}S$ can only proceed to T = 1 states.

3b. If the strength of the $\gamma$-transition from a $1^+$ state in $^{28}Si$ to the $0^+$ ground state exceeds 30 mW.u., the initial state has T = 1.

4. Almost all $\beta$-transitions within a T-multiplet concern the $\beta^+$ decay of the most proton-rich component ($T_{zi} = -T$, $T_{zf} = -T+1$). This leads to $M_F = (2T)^{1/2}$.

5. The $\alpha$-particle decay from T = 1 states in $^{24}Mg$ leading to the $^{20}Ne$ ground state is forbidden.

The neutron decay from analogue states in neutron-rich nuclei ($T_z > 0$) is forbidden.

2 June 1980

P.M. Endt

C. van der Leun

Appendix 28

## NOTE ON THE CALCULATION OF ADOPTED RELATIVE GAMMA BRANCHINGS

Date: April 17, 1980
From: J.W. Tepel

For any specific level for which gamma branchings are to be calculated let $I_{mn}$ be the measured intensity of the $n^{th}$ gamma in the $m^{th}$ data set. Furthermore, let $p_{mn} = 1/\delta I^2_{mn}$ .

We have the following sets of measurements for which the normalization factors $\alpha_m$ have to be calculated:

$$\underbrace{\begin{matrix} I_{11} \\ I_{12} \\ I_{13} \\ \vdots \end{matrix}}_{1^{st}\text{ data set}} \qquad \underbrace{\alpha_2 \left\{ \begin{matrix} I_{21} \\ I_{22} \\ I_{23} \end{matrix} \right.}_{2^{nd}\text{ data set}} \qquad \ldots\ldots \qquad \underbrace{\alpha_m \left\{ \begin{matrix} I_{m1} \\ I_{m2} \\ I_{m3} \end{matrix} \right.}_{m^{th}\text{ data set}} \qquad \ldots\ldots$$

Step 1: Normalize any particular gamma to 100 for each data set (say the strongest line) and scale all measurements. For the above example we could have $I_{11}=I_{21}=\ldots=I_{m1}=100$

Step 2: Calculate the usual weighted averages

$$\bar{I}_{.j} = \sum_m p_{mj}\, I_{mj} \Big/ \sum_m p_{mj}$$

Step 3: Ignoring the dependence of the averages $\bar{I}_{.j}$ on the normalization factors $\alpha_m$ , we can determine the latter by least-squares methods:

For $m > 1$ we have

$$\alpha_m = \sum_j p_{mj}\, \bar{I}^2_{.j} \Big/ \sum_j p_{mj}\, \bar{I}_{.j}\, I_{mj} \, .$$

Now calculate the new intensities for data sets 2, ... by $I^{new}_{mj} = \alpha_m I^{old}_{mj}$ and repeat steps 2 and 3 until say $|\alpha_m - 1| < 0.001$ .

Finally calculate weighted averages and normalize to 100 .

Nuclear-Decay Data: The Statement of Uncertainties

At the annual general meeting of the International Committee for Radionuclide Metrology (ICRM) held last June at the Physikalisch-Technische Bundesanstalt, it was suggested that letters should be sent to the editors of journals that publish nuclear-decay data, drawing attention to the need for specific statements of the uncertainties that are associated with such data. Authors frequently fail to state clearly the nature of their estimates of uncertainty, and not all editors insist on such clarity, so that evaluators of nuclear-decay data often find that it is necessary to consult with the individual authors to arrive at the weighting factors appropriate to their data. If uncertainties could be clearly characterized in the abstracts or in the text of papers reporting values of nuclear parameters, there would be a corresponding shortening of the time required for the data to be evaluated and tabulated.

There are many methods of stating estimates of conventional random and systematic uncertainties that are acceptable, provided that the methods used are described. Thus random error may be stated as: (i) the estimate of the standard deviation (or the square root of the variance), which is in the same units as the observed data and indicates the order of magnitude of the spread of the data: (ii) the standard error (or the estimated standard deviation of the mean of the distribution); and (iii) the estimated limits for the mean at stated levels of confidence (CL) (e.g. limits at the 99-percent CL define the range within which there is a 99-percent probability of including the mean of a population). Provided that the author states the number of independent measurements made of the given parameter, or the number of degrees of freedom, these statements of random uncertainty are related uniquely to each other.

The other component of the overall uncertainty is the estimate of possible systematic error. The significance, or meaning, of the estimate of systematic uncertainties should be clearly stated and also related to the method chosen to state the random uncertainties. Thus an estimate of maximum conceivable systematic uncertainties would logically be combined with a random uncertainty at a 99-percent confidence level. An appropriate fraction of the estimate of maximum conceivable systematic uncertainty would be chosen to match smaller random confidence levels. The methods used to combine random and systematic uncertainties should also be stated by authors, and an explicit listing of all components of these uncertainties will allow an evaluator of nuclear data to "unravel" the statements of uncertainty and to choose weighting factors that are consistent for all the data to be evaluated. The need for expressing all nuclear-data measurements with the greatest possible clarity has been forcefully emphasized by Schmidt and Bartholomew (1975).

The philosophy of the estimation and statement of overall uncertainty is currently being studied by specialists at the Bureau International des Poids et Mesures, and their conclusions will be duly reported.

This short note has been discussed, directly or indirectly, with Y. Le Gallic, D.D. Hoppes, J. Legrand, J.S. Merritt, J.W. Muller, T. Radoszewski, A. Rytz, and S. Wagner, all of whose many and diverse opinions I have attempted to combine into an acceptable whole. All these colleagues are, however, agreed that irrespective of the philosophical approaches to the treatment of uncertainty, all estimates of the parts of stated uncertainties should be fully enumerated and carefully evaluated.

National Bureau of Standards
Washington, D.C. 20234

W.B. Mann, President
International Committee for Radionuclide Metrology

## REFERENCE

Schmidt, J.J., and Bartholomew, G.A. (1975). Presentation of Results of Nuclear Data Measurements, Int. J. appl. Radiat. Isotopes, 26, 45.

# LIST OF JOURNALS

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Atomkernenergie
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Radiotekhnika i Electronika Akademiya Nauk SSSR
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Zeitschrift fur Naturforschung
Zeitschrift fur Physik

## Role of "Physics" Interpretation in the A-chain Evaluation Process

C. W. Reich

REICH raised for discussion the question of what attention the A-chain evaluator should direct toward evaluating (and correcting) the "nuclear-structure physics" content of the various papers. In the course of the evaluation of the A = 158 mass chain at INEL, two papers were reviewed which stated that octupole-vibrational band structures had been identified in $^{158}Dy$ and $^{158}Er$. These statements, made by the authors on the basis of their measurements, represent "physics" conclusions and hence are of a nature somewhat different from statements concerning more usual and restricted conclusions concerning "measured" quantities such as, e.g., level energies, $I^{\pi}$ assignments. However, it was readily apparent, from rather general considerations of band structure in stongly deformed nuclei, that the octupole-band assignments proposed for these two nuclei were, almost certainly, incorrect. This situation, where an experienced evaluator finds probable errors in the physics interpretation of the results of a given experiment, can be expected to be a fairly common one. This problem was brought up in an attempt to provoke discussion and to generate, as far as reasonable, agreement as to what represents a consistent means of treating such questions. This would also be helpful in clarifying the issues for possible discussion at the forthcoming meeting of the members of the International Network. Although, due to a lack of time, the full scheduled presentation was not given, the following points and questions were raised:

(1) evaluators can be expected to encounter papers (whose experimental data will be included in the NDS) that contain nuclear-structure-related interpretations which the evaluator, from his experience and special expertise, recognizes to be incorrect;

(2) simply ignoring these interpretations is not always adequate to "squelch" them, since users of the NDS with less experience in the specific subject area may tend to infer that this implies tacit acceptance of the interpretation. Consequently, for example, these interpretations may find their way - indirectly - into horizontal compilations which rely for their base of "evaluated data" on those papers included in the Nuclear Data Sheets;

(3) it is thus desirable to include comments in the NDS about these suspected "errors", but in what detail should such comments be presented and in what format? (Should the International Network consider this problem, to see if some uniformity in approach can be adopted?)

(4) Clearly, the consideration of the corrections of incorrect nuclear-stucture interpretations presented in the papers whose data are included in the A-chain evaluations cannot consume an inordinate amount of the evaluator's time. If it were to do so, the A-chain cycle time would become unacceptably long. Thus, the interpretation errors cited will probably be restricted largely to those which appear "obvious" to the knowledgeable evaluator.

## Addresses of Active and Potential Members of the NSDD Network

(Active mass-chain evaluation centres are indicated by an asterisk, NSDD distribution centres are indicated by an +)

| Code | Centre/Group | | Address | Head of Project or Centre |
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| 1B | US/NDP | * | Nuclear Data Project<br>Oak Ridge National Laboratory<br>Oak Ridge, Tennessee 37830, USA | M. Martin |
| 1C | US/LBL | * | Lawrence Berkeley Laboratory<br>University of California<br>Berkeley, Calif. 94720, USA | C.M. Lederer |
| 1D | US/INEL | * | EG and G Idaho, Inc.<br>P.O. Box 1625<br>Idaho Falls, Idaho 83401, USA | R.L. Heath |
| 1E | US/UP | * | University of Pennsylvania<br>Philadelphia, Penns. 19174, USA | F. Ajzenberg-Selove |
| 2A | USSR/CAJAD | *+ | Institut Atomnoi Energii<br>I.V. Kurchatova<br>46 Ulitsa Kurchatova<br>Moscow, D-182, USSR | F.E. Chukreev |
| 2B | USSR/LIYaF | * | Data Centre<br>Leningrad Nuclear Physics Inst.<br>Gatchina, Leningrad Region<br>188350, USSR | I.A. Kondurov |
| 3A | NED/UTRECHT | * | Fysisch Laboratorium<br>Princetonplein 5, P.O. Box 80 000<br>3508 TA Utrecht, The Netherlands | C. van der Leun |
| 4A | UK/Liverpool | * | Oliver Lodge Laboratory<br>University of Liverpool<br>Liverpool L69 3BX, U.K. | P. Twin |
| 5A | FRG/FIZ | *+ | Fachinformationszentrum Energie, Mathematik GmbH<br>Kernforschungszentrum<br>D-7514 Eggenstein-Leopoldshafen 2 | H. Behrens |
| 6A | FR/LMRI | | Centre d'Etudes Nucleaires de Saclay<br>B.P. No. 2<br>F-91190 Gif-sur-Yvette, France | J. Legrand |

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| 7A | IAEA/NDS | + | Nuclear Data Section<br>International Atomic Energy Agency<br>P.O. Box 100<br>A-1400 Vienna, Austria | A. Lorenz |
| 8A | NEA/DB | + | NEA Data Bank<br>B.P. No. 9<br>F-91190 Gif-sur-Yvette<br>France | N. Tubbs |
| 9A | CBNM/Geel | | Bureau Central de Mesures Nucleaires<br>C.E.C.<br>Steenweg naar Retie<br>B-2440 Geel, Belgium | W. Bambynek |
| 10A | JAP/JAERI | * | Japan Atomic Energy Research Institute<br>Division of Physics<br>Tokai-Mura, Naka-Gun<br>Ibaraki-Ken 319-11, Japan | T. Tamura |
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| 12A | KUW/ISR | * | Kuwait Institute for Scientific Research<br>Shuwaik, Kuwait | A. Shihab-Eldin |
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