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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

FIRST RESULTS OF FENDL-1 TESTING AND START OF FENDL-2

Summary Report of a Consultants' Meeting
organized by the International Atomic Energy Agency
and held in Vienna, Austria, 25-28 June 1990

Prepared by A.B. Pashchenko and D.W. Muir

November 1990

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

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Abstract

The present report contains the summary of the IAEA Consultants' Meeting on "First Results of FENDL-1 Testing and Start of FENDL-2". The meeting conclusions and recommendations and future plans for the development of a nuclear data base for fusion reactor technology are included in this summary report.

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1. Introduction

The Agency's programme to create a modern and internationally available Fusion Evaluated Nuclear Data Library (FENDL) has the objective of developing a processed and tested nuclear data library for D-T fusion reactors in support of the design and analysis activities in national and international fusion reactor projects. This programme is supported by several IAEA Coordinated Research Programmes, and involves the cooperation of a number of national nuclear data centres and research laboratories.

FENDL-1, the first version of the library, includes a general purpose library consisting of evaluated nuclear data for the main elements and isotopes of fusion reactor fuel, blanket, structural and shielding materials. These data have been selected from five national evaluated nuclear data libraries, namely,

- the ENDF/B-VI U.S.A. library maintained by the National Nuclear Data Center at the Brookhaven National Laboratory;
- the BROND library maintained by the U.S.S.R. Nuclear Data Center at the Physics and Energetics Institute in Obninsk;
- the JENDL-2 and -3 Japanese nuclear data libraries maintained by the JAERI Nuclear Data Center;
- the EFF-1 European Fusion File maintained by ECN Petten, Netherlands;
- the ENDL-84 library maintained by the Lawrence Livermore National Laboratory in the U.S.A.;

In addition, FENDL will contain the following special purpose libraries:

- the International Reactor Dosimetry File for use in neutron dosimetry, maintained by the Nuclear Data Section with the support of the Institut für Radiumforschung und Kernphysik, Vienna, Austria;
- the Charged Particle Data Library DATLIB, maintained by the Technical University of Graz, Austria;
- a large comprehensive activation data library covering several thousand activation reactions selected and compiled from various national files; and
- a library of gamma-ray interaction data.

The microscopic data files are being processed into forms usable in neutronic and safety calculations in the IAEA/NDS, with the support of the laboratories which contribute to the FENDL project. In particular, FENDL is being converted into a fine-mesh point data library and from this a multigroup data library for use in discrete ordinate codes and a library for use in Monte-Carlo code calculations will be prepared.

Following the recommendation of the 17th INDC Meeting and the established IAEA programme for the development of a nuclear data library for fusion reactor technology, the IAEA Nuclear Data Section convened a Consultants' Meeting on "First Results of FENDL-1 Testing and Start of FENDL-2" at the IAEA Headquarters in Vienna on 25-28 June 1990.

The main objectives and specific tasks of this Consultants' Meeting were the following:

(1) to finalize the review of FENDL-1, especially:

- to discuss the problems encountered in FENDL-1 files,
- to review gamma production and double-differential cross-section data in FENDL-1 for ^{52}Cr, ^{56}Fe, $^{58,60}Ni$, and Pb,
- to review and approve activation cross sections for incorporation into FENDL-1, and
- to review and approve dosimetry neutron cross sections (IRDF update) for incorporation into FENDL-1,
- to review and approve charged particle nuclear data for incorporation into FENDL-1,
- to review user requirements for processed data;

(2) to start preparation of FENDL-2, especially:

- to identify new evaluations to replace FENDL-1 files in developing FENDL-2.

It should be emphasized that considerable preparation work was undertaken by the meeting participants in the months prior to the meeting. Two very important recent developments were the free, international release of both the U.S. ENDF/B-VI and the Japanese JENDL-3 general-purpose libraries. Many activation files (REAC-2(USA), REAC-ECN-5(Netherlands), ENDF/B-VI(USA), BOSPOR-86 and ADL-90(both USSR) and SINCROSACT(JAPAN)) were received during this time at the IAEA from the participants of the activation data intercomparison. Data from these files as well as experimental (EXFOR) data were used by NDS personnel to prepare, prior to the meeting, many graphical comparisons, so that the efficiency of the joint work during the meeting was very high.

2. Meeting Proceedings

The Consultants' Meeting was opened by Prof. V.A. Konshin, Director of the IAEA Division of Physical and Chemical Sciences. In his opening talk, Prof. Konshin emphasized the important place of Nuclear Data Section activity in the Agency's fusion related programme of the FENDL creation, which is intended to serve as a reference fusion nuclear data library for use in national and international fusion reactor projects and activities. Then, in an introductory session, D.W. Muir briefly reviewed the history of FENDL. The work of the meeting then proceeded with four scientific sessions and four working group meetings. The meeting agenda is given in Appendix 1.

The second session of the meeting, chaired by Dr. D. Larson, was intended to provide a general overview of general purpose file for FENDL. Dr. J. Kopecky presented an extensive review on the status of the European Fusion File (EFF) Project, which is sponsored by the European Community's Fusion Technology Programme. The programme is directed to the short-term needs of the NET team which designs the NEXT European Torus. A clear, general picture on the EFF project status has emerged from this talk.

The programme of the EFF-project is in its second phase, after the successful completion of the EFF-1 data file. The second phase programme has been defined from 1989 to 1991. The emphasis of the first phase was on the improvement of the tritium breeding and neutron multiplication cross-sections, whereas the second phase emphasizes the improvement of a shielding data base. In practice the EFF-1 and EFF-2 projects aim to supplement the JEF-1 and JEF-2 data files, respectively, with high-energy data relevant for fusion applications. Therefore the two projects are closely related.

Dr. J. Kopecky emphasized that there are still many problems to be solved. First of all the EFF-2 file needs to be benchmarked and the feedback of integral data experiments should be used to improve the data file. It is expected that still quite some work is needed to obtain reliable photon production data that are consistent with the neutron data. Also some work is needed to include distributions of all emitted particles and recoil nuclei on the files in order to enable accurate kerma assessments. A major activity will be the systematic update of covariance information, not only for smooth cross-sections, but also for resonance parameters and for energy-angle distributions of neutrons and photons.

In conclusion of his talk Dr. J. Kopecky stressed that the cooperation between the various regional nuclear data projects and FENDL is of great interest to these projects, in particular to compare and discuss the various evaluations, to calculate derived data files to perform benchmark studies. Therefore, an intensive cooperation between the EFF and FENDL project is recommended. The recent interest from the ITER team for a common data base should intensify this cooperation. Similar remarks hold for the cooperation between the European Activation File project and FENDL. Here the very large number of data requests can only be met by worldwide international cooperation.

Dr. D.C. Larson presented an extended talk on Structural Material ENDF/B-VI Data for Fusion and provided a talk on Comparison and Analysis of File 3 Cross-Sections from BROND, EFF-II, ENDF/B-VI, JEF-II and JENDL-III.

Prof. A.V. Ignatyuk reported on the "New Evaluated Data Files of BROND Library" and Dr. P.G. Young presented a review talk on "Light-Material ENDF/B-VI Evaluations for Fusion". A "Comprehensive Analysis of Energy Distributions of Secondary Particles in FENDL Data Files" was presented by Dr. V.G. Pronyaev. Particular attention was paid to the comparison of secondary neutron and γ-ray energy spectra for chromium and iron evaluation data files from BROND and ENDF/B-VI libraries. It was shown that these two independently carried out evaluations are in a good agreement. It raises the reliability of the microscopic data for their use in ITER project. Prof. D. Seeliger presented a very interesting contribution on the "Application of the SMC/SMD Code EXIFON for Calculations of Nuclear Data in ENDF/B Format needed for Fusion Application". An unique description of (n,p) and (n,α) activation cross-sections as well as emission spectra were demonstrated within a pure multistep approach.

The third session of the meeting, chaired by Dr. J. Kopecky, was focused on activation and dosimetry data to be incorporated into FENDL-1. Dr. F.M. Mann presented a general overview on the "ENDF/B-VI Special Purpose Files (Activation and Dosimetry)". Prof. H.K. Vonach provided an extensive review on the progress being done in co-operation of IRK and IAEA/NDS on updated IRDF-90 File and presented a summary information on the reactions to be included in IRDF-90. Dr. J. Kopecky presented further information about the associated European Activation File (EAF) project. The programme of EAF Project is directed to long-term needs in the development of a Fusion Demonstration Reactor, in particular in connection with the study of low-activation materials. There is a very large task to update the activation and transmutation library with uncertainties. Dr. J. Kopecky stressed that the amount of work is quite large and therefore active involvement of users is required to set priorities. Dr. R.A. Forrest provided a talk on the U.K. work on activation related nuclear databases and codes. The status of the nuclear databases UKACT, UKDECAY and UKDOSE required as input to the inventory code FISPACT was reviewed by Dr. R.A. Forrest and applications of the calculational benchmark comparisons and the future directions of work were given in his talk.

Dr. N. Yamamuro presented a very interesting calculation result of long-lived isotope production with a simplified-input nuclear cross-section calculation system (SINCROS-II). The accuracy of the calculation is expected to be good, because the parameters used in the calculation are cross-checked with the experimental data and the systematic trends of the calculated cross-sections were demonstrated. Dr. F.M. Mann presented a review talk on the status of REAC-2 Activation Data Library. Dr. E. Betak provided a talk on the work being done on an updated PC Version of fully pre-equilibrium computer code PEQAG2 with gamma emission. Dr. A.A. Filatenkov presented measurements results of $^{109}Ag(n,2n)^{108m}Ag$, $^{151}En(n,2n)^{150}En$ and $^{153}En(n,2n)^{152}En$ reactions at neutron energy ~14 MeV. Dr. A.B. Pashchenko presented a review talk on the status of the intercomparison of activation cross-section data from evaluated neutron data files, submitted to IAEA for incorporation into the FENDL-1 activation library. The intercomparison was made graphically by plotting all files against the EXFOR data.

The fourth and fifth sessions, chaired by Dr. D.W. Muir, were devoted to the short topics of charged particle nuclear data (see report of Working Group III) and multigroup processing issues, respectively. A highlight of the multigroup session was the paper presented by Dr. S. Ganesan on progress and plans of the activity underway in the IAEA/NDS to supply FENDL data to fusion-project personnel in the particular forms required in their applications (e.g., multigroup transfer matrices). Dr. Ganesan reported that it is expected that an extensive 175-group (neutrons) by 42-group (gamma-rays) multigroup set, based mainly on ENDF/B-VI, will be completed using NJOY 89 by the end of 1990. A library for input to MCNP will follow in the first half of 1991. Covariance processing is now planned for the second half of 1991. At the suggestion of the meeting participants the NDS is examining ways of combining the isotopic multigroup sets produced by NJOY into more compact natural-element sets, prior to external distribution. Separate isotopic sets will, in any case, be retained for special needs.

On the second day after lunch the meeting participants split into four Working Groups to summarize the results of the meeting presentations and discussions, and to formulate the meeting conclusions and recommendations. The draft of the meeting conclusions and recommendations, prepared by the chairmen of the Working Groups was discussed at the summary session, chaired by Dr. J.J. Schmidt, the Head of the IAEA Nuclear Data Section, on the final day and adopted with minor modification. These are given in Appendix II.

3. Meeting Attendance

The meeting was attended by 19 specialists from 11 Member States of which 7 consultants were paid by the Agency. In addition, a number of scientists working in the field who were present at headquarters were also invited to participate in the meeting. The list of participants is given in Appendix III.

4. Future Plans

The conclusions and recommendations of the experienced consultants in attendance, regarding the fusion-related nuclear data needs and activities required after completion of FENDL-2 (scheduled for the end of 1992), were also prepared during the meeting.

Review topics included the following:

(i) Nuclear data needs after FENDL-2
(Prof. H. Vonach, IRK, Vienna, Austria).

(ii) Future of FENDL
(Dr. E.T. Cheng, General Atomic, San Diego, U.S.A.).

(iii) Need for FENDL-2 benchmark testing
(Prof. A.I. Ignatyuk, FEI, Obninsk, U.S.S.R.).

(iv) Activation libraries and general purpose files-activities after FENDL-2
(Dr. R.A. Forrest, AERE Harwell, U.K., and Dr. J. Kopecky, ECN Petten, Netherlands).

Complete texts of these reviews are given in Appendix IV.

5. Next Meeting

The IAEA will organize on 19-21 November 1990 an Advisory Group Meeting on "Nuclear Data for Neutron Multiplication in Fusion Reactor First Wall and Blanket Materials", to be held in Chengdu, China, on 19-21 November 1990. A number of FENDL participants interested in data testing issues will attend that meeting. The question of an appropriate date for the next "combined" FENDL meeting, to select evaluations for FENDL-2 and to discuss additional results of benchmark testing of FENDL-1, was discussed. With the current plans, an appropriate time for the next combined meeting appears to be late in 1991.

Appendix I

IAEA Consultants' Meeting on

"First Results of FENDL-1 Testing and Start of FENDL-2"

June 25-28, 1990, IAEA Headquarters, Vienna
Meeting Room C-07/IV

Meeting Agenda

Monday, June 25

09:30-09:45 (1) Opening of the Meeting (V.A. Konshin)

09:45-10:00 (2) Election of Chairman, adoption of agenda, announcements, etc.

General Session

I. Introduction

Chairman: D. Larson

10:00-10:45 (1) History of FENDL
(D.W. Muir, IAEA/NDS)

II. Evaluated Nuclear Data Files for Fusion

Chairman: D. Larson

10:45-11:30 (2) The European Fusion File Project (EFF)
(J. Kopecky, ECN Petten, Netherlands)

11:30-11:45 Coffee Break

11:45-12:30 (3) Structural Material ENDF/B-6 Data for Fusion
(D. Larson, ORNL, USA)

12:30-14:00 Lunch

14:00-14:45 (4) New Evaluated Data Files of BROND
(A. Ignatyuk, FEI, Obninsk, USSR)

14:45-15:30 (5) Light-Material ENDF/B-VI Evaluations for Fusion
(P. Young, LANL, USA)

15:30-15:45 Coffee Break

15:45-16:30 (6) Analysis of Energy Distributions of Secondary Particles in FENDL Data Files
(V. Pronyaev, FEI, Obninsk, USSR)

16:30-17:15 (7) Comparison and Analysis of File 3 Cross-Sections from BROND, EFF-II, ENDF/B-VI, JEF-II and JENDL-III
(D. Larson, ORNL, USA)

17:15-17:45 (8) Measurements of Cross Sections of $^{109}Ag(n,2n)^{108m}Ag$, $^{151}Eu(n,2n)^{150}Eu$ and $^{153}Eu(n,2n)^{152}Eu$ Reactions at Neutron Energy ~14 MeV
(A. Filatenkov, RI Leningrad, USSR)

17:45-18:00 Coffee Break

18:00-18:30 (9) PEQAG2: An Updated PC Version of Fully Pre-equilibrium Computer Code with Gamma Emission
(E. Betak, Bratislava, Czechoslovakia)

18:30-19:00 (10) Application of the SMC/SMD Code EXIFON for Calculations of Nuclear Data in ENDF/B Format needed for Fusion Application
(D. Seeliger, TUD, GDR)

Tuesday, June 26

III. Activation and Dosimetry Data

Chairman: J. Kopecky

09:00-09:40 (11) ENDF/B-VI Special Purpose Files (Activation and Dosimetry)
(F.M. Mann, HEDL, USA)

09:40-10:20 (12) Review of Updated IRDF-90 File
(H. Vonach, IRK Vienna, Austria, and N. Kocherov, IAEA/NDS)

10:20-10:35 Coffee Break

10:35-11:00 (13) The European Activation File Project
(J. Kopecky, ECN Petten, Netherlands)

11:00-11:20 (14) A Study of the Environmental Impact of Fusion (UK activity on activation data for fusion technology)
(R. Forrest, Harwell, UK)

11:20-11:50 (15) Calculations of Long Lived Isotope Production with a Simplified Input Nuclear Cross Section Calculation System
(N. Yamamuro, Data Engineering Inc., Japan)

11:50-12:20 (16) REAC-2 Activation Data Library
(F.M. Mann, HEDL, USA)

12:20-14:00 Lunch

14:00-14:30 (17) Status of the Intercomparison of Activation Cross-Section Data from Evaluated Neutron Data Files Submitted to IAEA for Incorporation into the FENDL-1 Activation Library
(A. Pashchenko, IAEA/NDS)

IV. Charged Particle Nuclear Data (CPND)

Chairman: D. Muir

14:30-15:00 (18) Charged Particle Nuclear Data Files for Fusion
(J.J. Schmidt, IAEA/NDS)

15:00-15:30 (19) Discussion on CPND files to be incorporated in FENDL
(all)

15:30-15:45 Coffee Break

V. Multigroup Nuclear Data

Chairman: D. Muir

15:45-16:15 (20) International Working Group on Evaluation Intercomparison (ENDF/JENDL/JEF). Sub-group on Processing
(D. Larson, ORNL, USA)

16:15-16:45 (21) Multigroup and MCNP Input Libraries
(S. Ganesan, IAEA/NDS)

16:45-17:45 (22) Possibilities for Benchmark Testing of Nuclear Data Files for Fusion Application at TUD (discussion)
(D. Seeliger, TUD, GDR)

17:15-17:45 VI. Formation of the Working Groups (all)

Wednesday, June 27

WORKING GROUP I : Review of General Purpose File for FENDL:
14:00 - 18:00 hrs
Chairman: P. Young

WORKING GROUP II : Review of Activation Cross-Sections for Incorporation into FENDL-1: 09:00 - 18:00 hrs
Chairman: J. Kopecky

1. Detailed Evaluation Comparison following the "List of Reactions Important for Fusion"

2. Recommendations of Choice for FENDL-1.

WORKING GROUP III : Charged Particle Nuclear Data (CPND): 14:00 - 18:00 hrs
Chairman: J.J. Schmidt

WORKING GROUP IV : Covariances and Sensitivity Analysis: 14:00 - 18:00 hrs
Chairman: D.W. Muir

Thursday, June 28 9:00 - 18:00 hrs

(1) Preparation of WG Reports

(2) Report of WG I (review)

(3) Report of WG II (review)

(4) Report of WG III (review)

(5) Report of WG IV (review)

(6) Summary, conclusions and recommendations, actions

(7) Date and place of future FENDL meetings

Appendix II

FUSION EVALUATED NUCLEAR DATA LIBRARY

(FENDL)

CONCLUSIONS AND RECOMMENDATIONS

of the

IAEA CONSULTANTS' MEETING

ON FIRST RESULTS OF FENDL-1 TESTING AND START OF FENDL-2,

VIENNA, IAEA HEADQUARTERS, 25 - 28 JUNE 1990

WORKING GROUP I REPORT:

REVIEW OF GENERAL PURPOSE FILE FOR FENDL

(Chairman P. Young)

I. Agenda

The first item of business was to establish an agenda for the workshop. The topics below indicate the agenda that was identified.

II. Review Status of General Purpose Evaluations

The status of the evaluations already identified for FENDL-1 was reviewed, with particular attention directed at the completeness of the files. In particular, the data files for each material were checked for the presence of γ-ray production data (cross sections and spectra), correlated energy-angle emission data (MF=6), specification of energy spectra for secondary charged particles, presence of complete covariance data, and consistency of the cross section data with evaluations chosen for the FENDL-1 activation and dosimetry files. Additionally, comments were solicited and assembled rearding any known or suspected problems in the files. The complete results of this review are included in Table I.

It is recommended that the IAEA/NDS make the results of this review available to the various evaluators involved with FENDL-1 so that modifications to the files can be considered before input to the FENDL-2 library is specified.

During the review it was noted that the results of benchmark testing are needed to better assess the adequacy of the data for applications. It is hoped that a maximum of such information be available prior to reaching any decisions about the contents of FENDL-2.

III. Recommendations for New Evaluations in FENDL-1

At the ITER specialists' meeting on shielding calculations held at Garching, 12-14 February 1990, it was recommended that eight additional materials (Na, Mg, P, S, Cl, K, Ca and Ta) be added to the FENDL-1 library. At this workshop, evaluations were identified to meet this recommendation and are listed in Table II, together with comments similar to Table I.

IV. Comparison Plots for Assessing Evaluations

The value of the comparison plots prepared by Dunford, Tagesen, and Vonach for the present meeting was strongly endorsed by the working group. It was recommended that similar plots be prepared for the next meeting when recommendations will be made regarding FENDL-2 evaluations. Specifically, for each FENDL material, we recommend that the NDS prepare plots for MF=3 / MT=1, 2, 4, 16, 22, 28, 51, 52, 102, 103 and 107 for each candidate evaluation for FENDL-2, with experimental data included on the graphs. Additionally, we wish to emphasize the usefulness of the graphs of MF=4 Legendre coefficient data as well as the mentioned emission spectra shown at the present meeting by

Dr. Zhou. We recommend that similar plots be made available for neutron, gamma-ray, and changed-particle emission spectra prior to the next meeting. We recommend that Dr. Zhou make his emission spectra code available to the NDS to facilitate making these plots. We also recommend that the NDS consider preparation of graphs for the most important materials in the 175-group structure to facilitate comparisons of reactions with pronounced resonance structure. A final recommendation is that the NDS consider a coordinated approach to preparing such comparison plots through the neutron data centers.

V. Date of Next Meeting to Decide Evaluations for FENDL-2

The question of an appropriate date for the next meeting to select evaluations for FENDL-2 was discussed. With the currently known plans, an appropriate time appears to be late in 1991 for the next meeting. This time frame is consistent with having available data testing results for the selection task.

VI. Use of CRP Results

The value of the CRPs on double differential data, calculational methods, and level densities was recognized by the working group. We recommend that all evaluators preparing candidate evaluations for FENDL-2 fully utilize the CRP results.

TABLE I: Results of Review of FENDL-1 General Purpose Evaluations Identified at Previous Meetings +

Element	Library	γ-Ray Data	MF6 Data	Chg.Part. Spectra	Covariance Data	Act./Dos. Consistency	Comments
H	V6	Y	NA	Y	Y	-	Correct AWR for nuclear rather than atomic mass. Consider use of MF=30 for covariances.
D	BROND	Y	Y	Y	N	-	Several improvements have been made to the file since last meeting.
T	V6	Y	N	N	N	-	
Li-6	V6	Y	N*	NC	NC	-	
Li-7	V6	Y	N*	NC	Y	-	EFF-2/V6.1 will be considered for FENDL-2 after testing.
Be-9	V6	Y	Y	Y	N	-	Neutron emission spectra appear to be underestimated at back angles.
B-10	V6	Y	N*	NC	NC	-	
B-11	V6	Y	Y	Y	N	-	
C	V6	Y	N*	NC	Y	-	
N-14	BROND	Y	Y	Y	N	-	
N-15	BROND	Y	Y	Y	N	-	
O-16	V6	Y	N*	NC	N	-	
F-19	V6	Y	Y	Y	Y	N?	New BROND analysis using Pade approximates should be compared. (n,2n) cross sections might not be consistent with activation file.

Table I is continued on following page.
+ For explanations see end of Table I.

TABLE I (Contd.): Results of Review of FENDL-1 General Purpose Evaluations Identified at Previous Meetings +

Element	Library	γ-Ray Data	MF6 Data	Chg.Part. Spectra	Covariance Data	Act./Dos. Consistency	Comments
Al-27	JENDL-3	Y	N	N	N	N	
Si	BROND	Y	NC	Y	N	-	Use EFF-2 if completed in time. V6 isotopic evaluations will be available for consideration for FENDL-2.
Ti	JENDL-3	Y	N	NC	N	N	Ti-47 (n,p) not consistent with activation file.
V-51	V6	Y	N	N	Y	Y	
Cr-50, 52-54	V6	Y	Y	Y	Y	Y	Questions raised regarding resonance region for even Cr isotopes that should be checked.
Mn-55	V6/ JENDL-3	Y	Y	Y	Y	Y	Collaborative evaluation but only V6 contains MF=6 data.
Fe-54, 56-58	V6	Y	Y	Y	Y	Y	14 MeV neutron emission spectrum at 30° higher than Takahashi data in pre equilibrium region. Should be checked.
Co-59	V6	Y	N	N	Y	Y	
Ni-58, 60-62,64	V6	Y	Y	Y	Y	Y	Check first few resonances in Ni isotopes for completeness.
Cu-63,65	V6	Y	Y	Y	Y	Y	
Zr-90-92, 94,96	BROND	Y	Y	Y	N	N	Cheng recommended that isotopic evaluations be used. Zr-90(n,2n) not consistent with activation file.

Table I is continued on following page.
+ For explanations see end of Table I.

TABLE I (Contd.): Results of Review of FENDL-1 General Purpose Evaluations Identified at Previous Meetings +

Element	Library	γ-Ray Data	MF6 Data	Chg.Part. Spectra	Covariance Data	Act./Dos. Consistency	Comments
Nb-93	BROND	Y	Y	N	N	NC	Nb-93(n,n')Nb-93m and (n,2n)Nb-92m should be added from activation/dosimetry files.
Mo	JENDL-3	Y	N	N	N	N	Isotopic evaluations do not include γ-ray data. Recommend addition of γ-ray data before FENDL-2.
Sn	BROND	Y	N	Y	N	N	MF=3 is combination of full evaluation of major isotopes. MF=4,5 based on calculations for two isotopes.
Ba-134--138	V6	N	N	N	N	-	Fission product evaluations of limited scope.
W-182-184, 186	V6	Y	N	N	N	N	Some improvement in 14-MeV-neutron emission spectra possibly needed. Use of isotopic evaluations recommended by Cheng.
Pb-206--208	V6	Y	Y	N	Y	N	Pb-206(n,alpha) not consistent with activation file. Pb-204 evaluation is encouraged.
Bi-209	JENDL-3	Y	N	N	N	N	Bi-209(n,2n) and (n,γ) not consistent with activation file.

+ Table Explanation

Y = Yes, data present
N = No, data not present
* = Indicates excitation energy bins (pseudo levels used in lieu of MF=6)
NC = not complete but some data present
NA = not applicable

TABLE II: Additional Evaluations Recommended for FENDL-I+

Element	Library	γ-Ray Data	MF6 Data	Chg.Part. Spectra	Covariance Data	Act./Dos. Consistency	Comments
Na-23	JENDL-3	Y	N	N	N	N	
Mg	JENDL-3	Y	N	N	N	N	
P-31	V6	Y	N	N	N	Y	JENDL-3 only includes files thru MF=5 - no γ-ray data.
S	V6	Y	N	N	N	N	JENDL-3 has no γ-ray data.
Cl	V6	Y	N	N	N	-	JENDL-3 has no γ-ray data.
K	V6	Y	N	N	N	-	JENDL-3 has no γ-ray data.
Ca	JENDL-3	Y	N	N	N	-	
Ta-181	JENDL-3	Y	N	N	N	N	Should be compared with BROND update.

+ Same symbols used as in Table I.

WORKING GROUP II REPORT:

CONCLUSIONS AND RECOMMENDATIONS

of the

Activation Working Group

(Chairman: J. Kopecky)

Participants: J. Kopecky, R. Forrest, F. Mann, N. Yamamuro, A. Ignatyuk, V. Avrigeanu, Y. Nakajima, A. Pashchenko, A. Filatenkov, E. Cheng

I. Cheng's report on benchmark calculations should be published as an INDC(US) document:

II. A second benchmark calculation should be initiated to focus on adequacy of computer codes.

Action: 1) Forrest send to NDS, limited cross section library, decay library, flux, and irradiation history (by 1 September 1990)

2) Cheng supply NDS list of participants (by 1 September 1990)

3) NDS sends to participants identified by Cheng, materials (by 1 October 1990) in action 1

4) Participants send to Cheng results of calculations (by 1 February 1991)

5) Cheng to report by next FENDL meeting.

III. 1) Attached recommendations show which reactions were chosen based on the Forrest list:

2) For reactions not selected by group in their workshop, use ECN;

3) FENDL pointwise activation library will be kept in ECN format;

4) FENDL groupwise activation library will be processed similarly to that of the FENDL general purpose library.

IV. As part of the FENDL-2 library the following should be included:

1) a decay data library;

2) a complete cross section library (i.e., containing at least all targets with $t_{1/2}$ > 10 days and all reactions energetically possible for E_n < 20 MeV).

V. A. Pashchenko and the staff of the NDS are to be commended for the production of the review materials supplied to the activation working group. This package included the first set of plots comparing activation evaluations with experimental data and proved extremely useful in analyzing the large amount of data.

VI. For the next FENDL review of activation libraries, the NDS should prepare a similar package for the major activation reactions which includes:

1) the FENDL-1 activation library
2) the dosimetry and activation reactions also contained in the major general purpose files
3) the major activation libraries
4) experimental data
5) any contributed calculations

VII. At the next FENDL meeting the following activities (requiring the indicated amount of time) are proposed:

1) selection of evaluations for the FENDL-2 activation cross section library for the 256 major activation reactions (1 day)
2) selection of the sources for other reactions for inclusion in the FENDL-2 activation library
3) selection of the sources of decay data for inclusion in the FENDL-2 activation library (2+3: 1/2 day)
4) discussion of the results of the second activation benchmark calculation (1/2 day)
5) discussion of the importance of charged particle and photon-induced reactions for the activation problem
6) discussion of integral experimental testing of activation data (5+6: 1/2 day)

VIII. The next FENDL meeting should be held late in 1991.

ATTACHMENT

RECOMMENDATIONS OF THE WORKING GROUP (FENDL WORKING GROUP II)

(Chairman J. Kopecky)

Table 1

Overview of (n,p)-reaction cross-section data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			FCN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
1	N-14(n,p)C-14	N-14(n,p)C-14	+	+				+	+	+	ENDF/B-6
2	P-32(n,p)Si-32	P-32(n,p)Si-32	+		+					+	ADL-90
3	Cl-35(n,p)S-35	Cl-35(n,p)S-35	+	+	+				+	+	ADL-90
4	K-39(n,p)Ar-39	K-39(n,p)Ar-39	+	+	+	+			+	+	BOSPOR-86
5	K-41(n,p)Ar-41	K-41(n,p)Ar-41	+	+	+	+		+	+	+	BOSPOR-86
6	Sc-45(n,p)Ca-45	Sc-45(n,p)Ca-45	+	+	+	+			+	+	ADL-90
7	Co-60(n,p)Fe-60	Co-60(n,p)Fe-60	+	+	+					+	ADL-90
8	Cu-63(n,p)Ni-63	Cu-63(n,p)Ni-63	+	+	+		+	+	+	+	SINCROSACT
9	Zn-64(n,p)Cu-64	Zn-64(n,p)Cu-64	+	+	+	+	+		+	+	BOSPOR-86
10	Nb-93(n,p)Zr-93	Nb-93(n,p)Zr-93	+	+	+				+	+	ADL-90
11	Ba-137(n,p)Cs-137	Ba-137(n,p)Cs-137	+	+	+					+	ADL-90
12		Ce-142(n,p)La-142		+	+					+	ADL-90
13	Pb-204(n,p)Tl-204	Pb-204(n,p)Tl-204	+	+	+					+	ADL-90
14	Mg-24(n,p)Na-24-(&)	Mg-24(n,p)Na-24-(M)	+						+	+	IRDF-90
15		Mg-24(n,p)Na-24	+	+	+	+			E	+	IRDF-90
16	Ni-58(n,p)Co-58-(&)	Ni-58(n,p)Co-58-(M)	+	+					+	+	
17		Ni-58(n,p)Co-58	+	+	+	+		E	E	+	

Table 1 is continued on following page.

Table 1 (Contd.)

Overview of (n,p)-reaction cross-section data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
18		Ni-60(n,p)Co-60-(M)	+	+					+	+	IRDF-90
	Ni-60(n,p)Co-60-(&)										
19		Ni-60(n,p)Co-60	+	+	+	+		E	E	+	
20		Mo-94(n,p)Nb-94-(M)	+	+			+		+	+	SINCROSACT
	Mo-94(n,p)Nb-94-(&)										
21		Mo-94(n,p)Nb-94	+	+	+		+			+	SINCROSACT
22		AG-107(n,p)Pd-107-(M)	+	+			+		+	+	SINCROSACT
	Ag-107(n,p)Pd-107-(&)										
23		AG-107(n,p)Pd-107	+	+	+		+			+	SINCROSACT
24		Sb-125(n,p)Sn-125-(M)	+	+					+	+	ECN
	Sb-125(n,p)Sn-125										
25		Sb-125(n,p)Sn-125	+		+					+	ECN
26	SB-126(n,p)Sn-126	Sb-126(n,p)Sn-126	+							+	ECN
27		Dy-158(n,p)Tb-158-(M)	+	+						+	ECN
	Dy-158(n,p)TB-158-(&)										
28		Dy-158(n,p)Tb-158	+	+	+					+	ECN
29		Ta-182(n,p)Hf-182-(M)	+							+	ECN
	Ta-182(n,p)Hf-182-(&)										
30		Ta-182(n,p)Hf-182	+		+					+	ECN
31		Os-188(n,p)Re-188-(M)	+	+					+	+	ADL split by ECN
	Os-188(n,p)Re-188-(&)										
32		Os-188(n,p)Re-188	+	+	+					+	ADL
33		Sb-121(n,p)Sn-121-(M)	+	+					+	+	ADL split by ECN
	Sb-121(n,p)Sn-121-(M)										
34		Sb-121(n,p)Sn-121	+		+					+	ADL

Table 1 is continued on following page.

Table 1 (Contd.)

Overview of (n,p)-reaction cross-section data, contained in FENDL activation data intercomparison.

Explanation of symbols used in Tables 1 - 4.

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*) "TITLE OF PROBLEM" corresponds to R. Forrest's list of "Reactions Important for Fusion Activation", see pages 28 - 33 in IAEA report INDC(NDS)-223/GF(August 1989).

**) Comparison plots are available from the IAEA Nuclear Data Section.

E - These data exist, but have not yet been plotted.

&, M, N, G - Under the column "TITLE OF PROBLEM", the symbol "&" indicates the sum of cross sections forming all isomeric states. If particular isomeric products are required these are shown by G(ground state), M(1st isomer) or N(2nd isomer).

Table 2

Overview of (n, gamma)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison					EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	SINCROSACT	ENDF/ B–6	ADL –90			
1	C–13(n,gamma)C–14	C–13(n,gamma)C–14	+	+					+	ECN
2	Mg–26(n,gamma)Mg–27	Mg–26(n,gamma)Mg–27	+	+					+	ECN
3	Si–30(n,gamma)Si–31	Si–30(n,gamma)Si–31	+	+				+	+	HEDL
4	Si–31(n,gamma)Si–32	Si–31(n,gamma)Si–32								ECN
5	P–31(n,gamma)P–32	P–31(n,gamma)P–32	+	+		+		+	+	ENDF/B–6
6	S–34(n,gamma)S–35	S–34(n,gamma)S–35	+	+					+	ECN
7	Ar–40(n,gamma)Ar–41	Ar–40(n,gamma)Ar–41	+	+		+		+	+	ECN
8	Ca–40(n,gamma)Ca–41	Ca–40(n,gamma)Ca–41	+	+			+	+	+	ECN
9	Ca–44(n,gamma)Ca–45	Ca–44(n,gamma)Ca–45	+	+			+	+	+	ECN
10	CA–46(n,gamma)Ca–47	Ca–46(n,gamma)Ca–47	+	+			+		+	ECN
11	Cr–50(n,gamma)Cr–51	Cr–50(n,gamma)Cr–51	+	+		+	+	+	+	ENDF/B–6
12	Cr–54(n,gamma)Cr–55	Cr–54(n,gamma)Cr–55	+	+		+	+		+	ENDF/B–6
13	Mn–55(n,gamma)Mn–56	Mn–55(n,gamma)Mn–56	+	+		+	+	+	+	ENDF/B–6
14	Fe–56(n,gamma)Fe–57	Fe–56(n,gamma)Fe–57	+	+			+	+	+	ENDF/B–6
15	Fe–57(n,gamma)Fe–58	Fe–57(n,gamma)Fe–58	+	+			+	+	+	ENDF/B–6
16	Fe–58(n,gamma)Fe–59	Fe–58(n,gamma)Fe–59	+	+		+	+		+	ENDF/B–6
17	Fe–59(n,gamma)Fe–60	Fe–59(n,gamma)Fe–60	+	+			+		+	ECN
18		Co–58(n,gamma)Co–59	+	+					+	ECN
19		Co–59(n,gamma)Co–60	+	+		+	+		+	ECN
20		Co–59(n,gamma)Co–60–(M)	+	+					+	ECN
21		Co–60(n,gamma)Co–61	+	+			+		+	ECN
22		Ni–58(n,gamma)Ni–59	+	+		+	+		+	ENDF/B–6

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison					EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	SINCROSACT	ENDF/ B-6	ADL -90			
23	Ni-61(n,gamma)Ni-62	Ni-61(n,gamma)Ni-62	+	+			+		+	ENDF/B-6
24	Ni-62(n,gamma)Ni-63	Ni-62(n,gamma)Ni-63	+	+		+	+	+	+	ENDF/B-6
25	Cn-63(n,gamma)Cn-64	Cn-63(n,gamma)Cn-64	+	+	+	+	+	+	+	ENDF/B-6
26	Zn-64(n,gamma)Zn-65	Zn-64(n,gamma)Zn-65	+	+	+		+	+	+	ECN
27	Zr-92(n,gamma)Zr-93	Zr-92(n,gamma)Zr-93	+	+		+	+	+	+	BROND
28	Zr-94(n,gamma)Zr-95	Zr-94(n,gamma)Zr-93	+	+		+	+	+	+	BROND
29	Mo-98(n,gamma)Mo-99	Mo-98(n,gamma)Mo-99	+	+	+	+	+	+	+	ECN
30	Pd-104(n,gamma)Pd-105	Pd-104(n,gamma)Pd-105	+	+			+		+	ECN
31		Pd-104(n,gamma)Pd-105-(M)	+						+	ECN
32	Pd-105(n,gamma)Pd-106	Pd-105(n,gamma)Pd-106	+	+			+	+	+	ECN
33	Pd-107(n,gamma)Pd-108	Pd-107(n,gamma)Pd-108	+	+			+		+	ECN
34	Cd-111(n,gamma)Cd-112	Cd-111(n,gamma)Cd-112	+	+			+	+	+	ECN
35	Sn-124(n,gamma)Sn-125	Sn-124(n,gamma)Sn-124	+	+		+	+	+	+	ECN
36		Sn-124(n,gamma)Sn-124-(M)	+						+	ECN
37	Sn-125(n,gamma)Sn-126	Sn-125(n,gamma)Sn-126	+				+		+	ECN
38	Sb-121(n,gamma)Sb-122	Sb-121(n,gamma)Sb-122	+	+			+	+	+	ECN
39		Sb-121(n,gamma)Sb-122-(M)	+						+	ECN
40	Sb-124(n,gamma)Sb-125	Sb-124(n,gamma)Sb-125	+				+		+	ECN
41	Cs-136(n,gamma)Cs-137	Cs-136(n,gamma)Cs-137	+				+		+	ECN
42		Ce-142(n,gamma)Ce-143	+				+		+	HEDL

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison ECN	HEDL	SINCROSACT	ENDF/ B-6	ADL -90	EX- FOR	PLOT**)	RECOMMENDATIONS
43	Nd-148(n,gamma)Nd-149	Nd-148(n,gamma)Nd-149	+	+			+	+	+	ECN
44	Nd-150(n,gamma)Nd-151	Nd-150(n,gamma)Nd-151	+	+			+	+	+	ECN
45	Sm-150(n,gamma)Sm-151	Sm-150(n,gamma)Sm-151	+	+			+	+	+	ECN
46	Sm-151(n,gamma)Sm-152	Sm-151(n,gamma)Sm-152	+	+			+		+	ECN
47	Sm-152(n,gamma)Sm-153	Sm-152(n,gamma)Sm-153	+	+			+	+	+	ECN
48	Eu-152(n,gamma)Eu-153	Eu-152(n,gamma)Eu-153	+	+			+		+	ECN
49	Eu-154(n,gamma)Eu-155	Eu-154(n,gamma)Eu-155	+	+			+	+	+	ECN
50	Gd-158(n,gamma)Gd-159	Gd-158(n,gamma)Gd-159	+	+			+	+	+	ECN
51	Hf-180(n,gamma)Hf-181	Hf-180(n,gamma)Hf-181	+	+			+	+	+	ECN
52	Ta-182(n,gamma)Ta-183	Ta-182(n,gamma)Ta-183	+				+		+	ECN
53	W-183(n,gamma)W-184	W-183(n,gamma)W-184	+	+			+	+	+	HEDL
54	W-186(n,gamma)W-187	W-186(n,gamma)W-187	+	+		+	+	+	+	HEDL
55	Os-192(n,gamma)Os-193	Os-192(n,gamma)Os-193	+	+			+	+	+	ECN
56	Pb-208(n,gamma)Pb-209	Pb-208(n,gamma)Pb-209	+	+		+		+	+	ENDF/B-6
57	Bi-209(n,gamma)Bi-210	Bi-209(n,gamma)Bi-210	+	+		+		+	+	ECN
58		Bi-209(n,gamma)Bi-209-(M)	+						+	ECN
59	Sc-45(n,gamma)Sc-46-(&)	Sc-45(n,gamma)Sc-46-(M)	+					+	+	ECN
60		Sc-45(n,gamma)Sc-46	+	+			+	+	+	ECN
61	Nb-93(n,gamma)Nb-94-(&)	Nb-93(n,gamma)Nb-94-(M)	+	+				+	+	ECN
62		Nb-93(n,gamma)Nb-94	+	+			+		+	ECN

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison ECN	HEDL	SINCROSACT	ENDF/ B–6	ADL –90	EX– FOR	PLOT**)	RECOMMENDATIONS
63		Mo–92(n,gamma)Mo–93–(M)	+	+	+				+	ECN
	Mo–92(n,gamma)Mo–93–(&)									
64		Mo–92(n,gamma)Mo–93	+	+	+		+		+	ECN
65		Rh–103(n,gamma)Rh–104–(M)	+	+	+			+	+	ECN
	Rh–103(n,gamma)Rh–103–(&)									
66		Rh–103(n,gamma)Rh–104	+	+				+	+	ECN
67		Pd–106(n,gamma)Pd–107–(M)	+						+	ECN
	Pd–106(n,gamma)Pd–107–(&)									
68		Pd–106(n,gamma)Pd–107	+				+		+	ECN
69		Pd–108(n,gamma)Pd–109–(M)	+					+	+	ECN
	Pd–108(n,gamma)Pd–109–(&)									
70		Pd–108(n,gamma)Pd–109	+	+			+		+	ECN
71		Cd–110(n,gamma)Cd–111–(M)	+	+				+	+	ECN
	Cd–110(n,gamma)Cd–111–(&)									
72		Cd–110(n,gamma)Cd–111	+	+			+		+	ECN
73		Sb–123(n,gamma)Sb–123–(M)	+	+				+	+	ECN
	Sb–123(n,gamma)Sb–124–(&)									
74		Sb–123(n,gamma)Sb–124	+	+			+		+	ECN
75		Eu–151(n,gamma)Eu–152–(M)	+	+				+	+	ECN
	Eu–151(n,gamma)Eu–152–(&)									
76		Eu–151(n,gamma)Eu–152	+	+			+		+	ECN

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison					EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	SINCROSACT	ENDF/ B–6	ADL –90			
77		Eu–153(n,gamma)Eu–154–(M)	?	+					+	ECN
	Eu–153(n,gamma)Eu–154–(&)									
78		Eu–153(n,gamma)Eu–154	+	+		+			+	ECN
79	Hf–181(n,gamma)Hf–182–(&)									
80		Ta–181(n,gamma)Ta–182–(M)	+	+				+	+	ECN
	Ta–181(n,gamma)Ta–182–(&)									
81		Ta–181(n,gamma)Ta–182	+	+				+	+	ECN
82		W–182(n,gamma)W–183–(M)	+	+					+	ECN
	W–182(n,gamma)W–183–(&)									
83		W–182(n,gamma)W–183	+	+		+			+	ECN
84		W–184(n,gamma)W–185–(M)	+	+					+	ECN
	W–184(n,gamma)W–185–(&)									
85		W–184(n,gamma)W–185	+	+					+	ECN
86		Re–187(n,gamma)Re–188–(M)	+	+	+			+	+	SINCROSACT
	Re–187(n,gamma)Re–188–(&)									
87		Re–187(n,gamma)Re–188	+	+	+	+			+	SINCROSACT
88		Os–188(n,gamma)Os–189–(M)		+					+	ECN
	Os–188(n,gamma)Os–189–(&)									
89		Os–188(n,gamma)Os–189	+	+		+			+	ECN
90		Os–189(n,gamma)Os–190–(M)	+	+					+	ECN
	Os–189(n,gamma)Os–190–(&)									
91		Os–189(n,gamma)Os–190	+			+			+	ECN

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison ECN	HEDL	SINCROSACT	ENDF/ B-6	ADL -90	EX- FOR	PLOT**)	RECOMMENDATIONS
92		Os-190(n,gamma)Os-191-(M)	+	+				+	+	ECN
	Os-190(n,gamma)Os-191-(&)									
93		Os-190(n,gamma)Os-191	+	+			+		+	ECN
94		Pt-192(n,gamma)Pt-193-(M)	+	+				+	+	ECN
	Pt-192(n,gamma)Pt-193-(&)									
95		Pt-192(n,gamma)Pt-193	+	+			+		+	ECN
96		Ag-107(n,gamma)Ag-108-(M)	+	+	+			+	+	SINCROSACT
	Ag-107(n,gamma)Ag-108-(M)									
97		Ag-107(n,gamma)Ag-108	+		+		+		+	SINCROSACT
98		Ag-109(n,gamma)Ag-110-(M)	+	+	+			+	+	HEDL
	Ag-109(n,gamma)Ag-110-(M)									
99		Ag-109(n,gamma)Ag-110	+	+	+		+		+	HEDL
100		Cd-112(n,gamma)Cd-113-(M)	+	+					+	ECN
	Cd-112(n,gamma)Cd-113-(M)									
101		Cd-112(n,gamma)Cd-113	+				+		+	ECN
102		Sn-120(n,gamma)Sn-121-(M)	+	+				+	+	ECN
	Sn-120(n,gamma)Sn-121-(M)									
103		Sn-120(n,gamma)Sn-121	+				+		+	ECN
104		Sn-122(n,gamma)Sn-123-(M)	+	+				+	+	ECN
	Sn-122(n,gamma)Sn-123-(M)									
105		Sn-122(n,gamma)Sn-123	+				+		+	ECN

Table 2 is continued on following page.

Table 2 (Contd.)

Overview of (n, gamma)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison					EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	SINCROSACT	ENDF/ B–6	ADL –90			
106	Te–122(n,gamma)Te–123–(M)	Te–122(n,gamma)Te–123–(M)	+	+				+	+	ECN
107		Te–122(n,gamma)Te–123	+				+		+	ECN
108	Ho–165(n,gamma)Ho–166–(M)	Ho–165(n,gamma)Ho–166–(M)	+					+	+	ECN
109		Ho–165(n,gamma)Ho–166	+				+		+	ECN
110	Re–185(n,gamma)Re–186–(M)	Re–185(n,gamma)Re–186–(M)	+	+	+			+	+	SINCROSACT
111		Re–185(n,gamma)Re–186	+				+		+	SINCROSACT
112	Hf–177(n,gamma)Hf–178–(N)	Hf–177(n,gamma)Hf–178–(M)	+						+	ECN
113		Hf–177(n,gamma)Hf–178	+				+		+	ECN
114	Hf–178(n,gamma)Hf–179–(N)	Hf–178(n,gamma)Hf–179–(M)	+					+	+	ECN
115		Hf–178(n,gamma)Hf–179	+				+		+	ECN
116	Ir–191(n,gamma)Ir–192–(N)	Ir–191(n,gamma)Ir–191–(M)	+					+	+	ECN
117		Ir–191(n,gamma)Ir–191	+				+		+	ECN

Table 3

Overview of (n,2n)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL –90	BOSPOR –86	SINCROS ACT	ENDF/ B–6			
1	Ar–40(n,2n)Ar–39	Ar–40(n,2n)Ar–39									postponed
2	Ca–42(n,2n)Ca–41	Ca–42(n,2n)Ca–41			E						postponed
3	Ca–43(n,2n)Ca–42	Ca–43(n,2n)Ca–42			E						postponed
4	Ca–44(n,2n)Ca–43	Ca–44(n,2n)–Ca–42			E						postponed
5	Ca–48(n,2n)Ca–47	Ca–48(n,2n)–Ca–47			+				+	+	ADL–90
6	Ti–45(n,2n)Ti–44	Ti–45(n,2n)Ti–44									
7	Ti–46(n,2n)Ti–45	Ti–46(n,2n)Ti–45			+	+			+	+	BOSPOR–86
8	Ti–47(n,2n)Ti–46	Ti–47(n,2n)Ti–46			E						postponed
9	Mn–54(n,2n)Mn–53	Mn–54(n,2n)Mn–53			E						postponed
10	Mn–55(n,2n)Mn–54	Mn–55(n,2n)Mn–54			+	+		+	+	+	ENDF/B–6
11	Fe–56(n,2n)Fe–55	Fe–56(n,2n)Fe–55			+	+		+	+	+	ENDF/B–6
12	Ni–58(n,2n)Ni–57	Ni–58(n,2n)Ni–57				+		+	+	+	ENDF/B–6
13	Ni–60(n,2n)Ni–59	Ni–60(n,2n)Ni–59			+			+	+	+	IRDF–90
14	Ni–64(n,2n)Ni–63	Ni–64(n,2n)Ni–63		+	+				+	+	ENDF/B–6
15	Zn–64(n,2n)Zn–63	Zn–64(n,2n)Zn–63		+	+	+			+	+	ADL–90
16	Zn–66(n,2n)Zn–65	Zn–66(n,2n)Zn–65	+	+	+	+			+	+	BOSPOR–86
17	Zr–94(n,2n)Zr–93	Zr–94(n,2n)Zr–93	+	+	+			+		+	BROND
18	Zr–96(n,2n)Zr–95	Zr–96(n,2n)Zr–95	+	+	+				+	+	BROND
19		Mo–99(n,2n)Mo–98		+	E					+	HEDL
20	Mo–100(n,2n)Mo–99	Mo–100(n,2n)Mo–99	+		+		+		+	+	SINCROSACT
21	Sb–121(n,2n)Sb–120	Sb–121(n,2n)Sb–120	+	+	+	+			+	+	ECN
22		Sb–121(n,2n)Sb–120–(M)									ECN

Table 3 is continued on following page.

Table 3 (Contd.)

Overview of (n,2n)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
23		Ce-142(n,2n)Ce-141		+	+				E	+	ADL-90
24	Nd-150(n,2n)Nd-149	Nd-150(n,2n)Nd-149	+	+	+	+			+	+	ADL-90
25	Sm-152(n,2n)Sm-151	Sm-152(n,2n)Sm-151	+	+	+	+			+	+	BOSPOR-86
26	Gd-160(n,2n)Gd-159	Gd-160(n,2n)Gd-159	+		+				+	+	ADL-90
27	Er-164(n,2n)Er-163	Er-164(n,2n)Er-163			+				+	+	ADL-90
28	Hg-195-(M)(n,2n)Hg-194	Hg-195-(M)(n,2n)Hg-194								-	
29		Hg-195(n,2n)Hg-194	+		+					+	ADL-90
30	Tl-203(n,2n)Tl-202	Tl-203(n,2n)Tl-202	+		+	+			+	+	ECN
31	Pb-206(n,2n)Pb-205	Pb-206(n,2n)Pb-205	+	+	E			+	+	+	ENDF/B-6
32		Pb-208(n,2n)Pb-207	+		E				E	+	ECN
33	Bi-208(n,2n)Bi-207	Bi-208(n,2n)Bi-207	+	+	+					+	ECN
34		Bi-208(n,2n)Bi-207-(M)	+							+	ECN
35	Bi-209(n,2n)Bi-208	Bi-209(n,2n)Bi-208	+	+	E	+		+	+	+	ENDF/B-6
36	Po-210(n,2n)Po-209	Po-210(n,2n)Po-210	+							+	ECN
37	Nb-92(n,2n)Nb-91-(&)	Nb-92(n,2n)Nb-91	+	+	E					+	ECN
38		Nb-92(n,2n)Nb-91-(M)	+	+						+	ECN
39	Nb-93(n,2n)Nb-92-(&)	Nb-93(n,2n)Nb-92	+	+	+	+			E	+	BOSPOR-86
40		Nb-93(n,2n)Nb-92-(M)	+			+			+	+	BOSPOR-86

Table 3 is continued on following page.

Table 3 (Contd.)

Overview of (n,2n)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
41	Nb-95(n,2n)Nb-94-(&)	Nb-95(n,2n)Nb-94	+		+					+	ECN
42		Nb-95(n,2n)Nb-94-(M)	+							+	ECN
43	Mo-92(n,2n)Mo-91-(&)	Mo-92(n,2n)Mo-91	+	+	+		+		E	+	SINCROSACT
44		Mo-92(n,2n)Mo-91-(M)	+	+			+		+	+	SINCROSACT
45	Mo-94(n,2n)Mo-93-(&)	Mo-94(n,2n)Mo-93		+	+		+		E	+	SINCROSACT
46		Mo-94(n,2n)Mo-93-(M)	+	+			+		+	+	SINCROSACT
47	Ag-107(n,2n)Ag-106-(&)	Ag-107(n,2n)Ag-106	+	+	+		+			+	SINCROSACT
48		Ag-107(n,2n)-Ag-106-(M)		+			+		+	+	SINCROSACT
49	Sb-123(n,2n)Sb-122-(&)	Sb-123(n,2n)Sb-122	+	+	+	+			E	+	ECN
50		Sb-123(n,2n)Sb-122-(M)	+	+					+	+	ECN
51	Ce-140(n,2n)Ce-139-(&)	Ce-140(n,2n)Ce-139	+	+	+					+	ECN
52		Ce-140(n,2n)-Ce-139-(M)	+	+					+	+	ECN
53	Tb-159(n,2n)Tb-158-(&)	Tb-159(n,2n)Tb-158	+	+	+					+	ECN
54		Tb-159(n,2n)Tb-158-(M)	+	+					+	+	ECN
55	Ho-165(n,2n)Ho-164-(&)	Ho-165(n,2n)Ho-164	+	+	+					+	ECN
56		Ho-165(n,2n)Ho-164-(M)	+	+					+	+	ECN

Table 3 is continued on following page.

Table 3 (Contd.)

Overview of (n,2n)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
57		Hf-178(n,2n)Hf-177	+	+	+					+	ADL-90
	Hf-178(n,2n)Hf-177-(&)										
58		Hf-178(n,2n)Hf-177-(M)	+	+						+	ADL-90 split by ECN
		Ta-178(n,2n)Ta-177	+		+	+					-
59										+	
		Ta-178(n,2n)Ta-177-(M)	+								-
60		Ta-179(n,2n)Ta-178	+		+					+	ADL-90
	Ta-179(n,2n)Ta-178-(&)										
61		Ta-179(n,2n)Ta-178-(M)	+							+	ADL-90 split by ECN
62		W-180(n,2n)W-179	+	+	+					+	
	W-180(n,2n)W-179-(&)										ADL-90 split by ECN
63		W-180(n,2n)W-179-(M)	+	+					+	+	
64		Os-192(n,2n)Os-191	+	+	E				E	+	ECN
	Os-192(n,2n)Os-191-(&)										
65		Os-192(n,2n)Os-191-(M)	+	+					+	+	ECN
66		Ir-191(n,2n)Ir-190	+	+	+	+			E	+	ADL-90
	Ir-191(n,2n)Ir-190-(&)										
67		Ir-191(n,2n)Ir-190-(M)	+	+					+	+	ADL-90 split by ECN
68		Pt-194(n,2n)Pt-193	+	+	+					+	ADL-90
	Pt-194(n,2n)Pt-193-(&)										
69		Pt-194(n,2n)Pt-193-(M)	+	+						+	ADL-90 split by ECN

Table 3 is continued on following page.

Table 3 (Contd.)

Overview of (n,2n)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL -90	BOSPOR -86	SINCROS ACT	ENDF/ B-6			
70	Au-197(n,2n)Au-196-(&)	Au-197(n,2n)Au-196	+	+	+	+	+		E	+	ENDF/B-6
71		Au-197(n,2n)Au-196-(M)	+	+			+		+	+	ENDF/B-6 split by ECN
72	Pb-204(n,2n)Pb-203-(&)	Pb-204(n,2n)Pb-203	+	+	E	+			E	+	ECN
73		Pb-204(n,2n)Pb-203-(M)	+	+					+	+	ECN
74	Ag-109(n,2n)Ag-108-(M)	Ag-109(n,2n)Ag-109	+		+		+			+	SINCROSACT
75		Ag-109(n,2n)Ag-109-(M)		+			+		+	+	SINCROSACT
76	Eu-151(n,2n)Eu-150-(M)	Eu-151(n,2n)Eu-150	+		+					+	ECN
77		Eu-151(n,2n)Eu-150-(M)	+						+	+	ECN
78	Ta-181(n,2n)Ta-181-(M)	Ta-181(n,2n)Ta-181	+		+	+				+	BOSPOR-86
79		Ta-181(n,2n)Ta-181-(M)	+						+	+	BOSPOR-86 split by ECN
80	Re-187(n,2n)Re-186-(M)	Re-187(n,2n)Re-186	+		+					+	ADL-90
81		Re-187(n,2n)Re-186-(M)	+	+			+			+	ADL-90 split by ECN
82	Hg-196(n,2n)Hg-195-(M)	Hg-196(n,2n)Hg-196	+		+					+	ADL-90
83		Hg-196(n,2n)Hg-196-(M)	+	+						+	ADL-90 split by ECN

Table 3 is continued on following page.

Table 3 (Contd.)

Overview of (n,2n)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	ISOTOPE/ REACTION	Evaluated data files presented for FENDL Intercomparison						EX– FOR	PLOT**)	RECOMMENDATIONS
			ECN	HEDL	ADL –90	BOSPOR –86	SINCROS ACT	ENDF/ B–6			
84	Eu–153(n,2n)Eu–152–(G)	Eu–153(n,2n)Eu–152	+		+					+	ADL–90
85		Eu–153(n,2n)Eu–152–(M)	+						+	+	ADL–90 split by ECN
86	Hf–179(n,2n)Hf–178–(N)	Hf–179(n,2n)Hf–178	+		+					+	ECN
87		Hf–179(n,2n)Hf–178–(M)	+						+	+	ECN
88	Hf–180(n,2n)Hf–179–(N)	Hf–180(n,2n)Hf–179	+		+					+	ECN
89		Hf–180(n,2n)Hf–179–(M)	+	+						+	ECN
90	Ir–193(n,2n)Ir–192–(N)	Ir–193(n,2n)Ir–192	+		+	+				+	ECN
91		Ir–193(n,2n)Ir–192–(M)	+						+	+	ECN

Table 4

Overview of (n,alpha)–reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	Evaluated data files presented for FENDL Intercomparison						EX- FOR	PLOT**	RECOMMENDATIONS
		ECN	HEDL	BOSPOR -86	ENDF/ B-6	ADL -90	SINCROSACT			
1	C-13(n,alpha)Be-9	–	–			–				
2	O-16(n,alpha)C-13	–		+		–		+	+	ENDF/B-6
3	O-17(n,alpha)C-14	–	–		+	–			+	ENDF/B-6
4	Ne-20(n,alpha)O-17	–				–		+		–
5	Na-23(n,alpha)F-20	–	–	+	+	+		+	+	BOSPOR-86
6	S-34(n,alpha)Si-31	–		+		+		+	+	BOSPOR-86
7	Cl-35(n,alpha)P-32	–		+		+		+	+	ADL-90
8	K-39(n,alpha)Cl-36	–		+		+		+	+	ADL-90
9	Ca-40(n,alpha)Ar-37	–	–			+			+	ADL-90
10	Ca-42(n,alpha)Ar-39	–				+			+	ADL-90
11	Ca-44(n,alpha)Ar-41			+		+		+	+	ADL-90
12	Ca-45(n,alpha)Ar-42	–				+			+	ADL-90
13	Sc-45(n,alpha)K-42	–		+		+			+	ADL-90
14	Ti-46(n,alpha)Ca-43	–				+			+	ADL-90
15	Ti-47(n,alpha)Ca-44)		–			+			+	ADL-90
16	Ti-48(n,alpha)Ca-45	–			+	+		+	+	ADL-90
17	Ti-49(n,alpha)Ca-46	–	–			+			+	ADL-90
18	V-51(n,alpha)Sc-47	–		+		+		+	+	ENDF/B-6
19	CR-50(n,alpha)Ti-47	–	–			+		+	+	ENDF/B-6
20	CR-52(n,alpha)Ti-49	–				+			+	ENDF/B-6
21	Ni-62(n,alpha)Fe-59	–	+	+	+	+	+	+	+	ENDF/B-6
22	Ni-63(n,alpha)Fe-60	–	+			+			+	ADL-90
23	Zn-66(n,alpha)Ni-63	+	+			+	+		+	ADL-90

Table 4 is continued on following page.

Table 4 (Contd.)

Overview of (n,alpha)-reaction data, contained in FENDL activation data intercomparison.

For explanations see end of the Table 1.

PLOT NO.	TITLE OF PROBLEM*)	Evaluated data files presented for FENDL Intercomparison						EX-FOR	PLOT**)	RECOMMENDATIONS
		ECN	HEDL	BOSPOR -86	ENDF/ B-6	ADL -90	SINCROSACT			
24	ZR-93(n,alpha)Sr-90	+	+			+			+	ECN
25	Sn-112(n,alpha)Cd-111	+	+			+			+	ECN
26	Os-190(n,alpha)W-187	+	+			+		+	+	ADL-90
27	PB-206(n,alpha)Hg-203	+	+		+	+		+	+	ECN
28	Al-27(n,alpha)Na-24-(&)			Na-24				+	+	IRDF-90 split by ECN
29	V-49(n,alpha)Sc-46-(&)					Sc-46			+	ADL-90 split by ECN
			Co-60-(M)				Co-60-(G)			IRDF-90 split by ECN
30	Cu-63(n,alpha)Co-60-(&)			Co-60		Co-60		+	+	
			Co-60				Co-60-(M1)			IRDF-90
		Ba-137-(M)	Ba-137-(M)							ECN
31	Ce-140(n,alpha)Ba-137-(&)					Ba-137		+	+	
		B-137	Ba-137							ECN
		Ir-194-(M)	Ir-194-(M)							ADL-90 split by ECN
32	Au-197(n,alpha)Ir-194-(&)					Ir-194		+	+	
		Ir-194	Ir-194							ADL-90
		Cd-112-(M)				Cd-112				ECN
33	Sn-116(n,alpha)Cd-112-(M)		Cd-112-M						+	
		Cd-112								ECN
		Hf-179-(M1)				Hf-179				ECN
34	W-182(n,alpha)Hf-179-(N)	Hf-179-(M2)						+	+	ECN
		Hf-179								ECN

WORKING GROUP III REPORT:

CONCLUSIONS AND RECOMMENDATIONS OF THE CHARGED PARTICLE NUCLEAR DATA (CPND) WORKING GROUP

(Chairman: J.J. Schmidt)

The present status and availability of evaluated CPND libraries is described in Appendix A. An additional reference handbook entitled "Nuclear Physics Constants for Thermonuclear Fusion" by S.N. Abramovich et al. from the Central Scientific Research Institute on Information and Techno-Economic Research on Atomic Science and Technology, Moscow, has been published in 1989 and is currently being translated into English by Mr. A. Lorenz, previous NDS staff member. This translation will be published as INDC(CCP)-report in about 2 months. This handbook contains experimental as well as spline-fit and/or theoretical data for all charged-particle reactions of interest in conventional as well as advanced magnetic confinement based fusion reactor research.

The DATLIB library is at present the only recently updated charged-particle nuclear data (CPND) library immediately available, for which also software for producing $\langle\sigma v\rangle$ data exists. The ECPL-library is currently being updated. The data from the Soviet handbook have been requested to be provided by the authors in digital form, experimental data in EXFOR format (where still not available), spline fit and theoretical data in tabular form.

It is therefore recommended to put into FENDL-1 the DATLIB Library plus the $\langle\sigma v\rangle$ generation software, supplemented by a few neutron-source reactions from the DROSG 87 library.

For FENDL-2 a comparison between DATLIB and the then available updated ECPL and the CPND from the new Russian handbook should be performed and the best data be selected for inclusion into FENDL-2. In this intercomparison should also be included recent evaluations by Dr. Bosch/Garching of charged-particle reactions for JET and new evaluations of the lightest nuclei reactions currently being performed at Livermore and Los Alamos.

Status of CPND Libraries

Evaluated Data

(1) Light-element neutron source reactions:

DROSG-87: available with related codes on tape/diskette; IAEA-NDS-87. Handbook on Nuclear Activation Data, IAEA, 1987, Technical Report 273, p.83-162.

DROSG-90 will be available soon.

(2) Charged-particle reactions with light isotopes Z = 1 to 5
Feldbacher, GRAZ-87. ("DATLIB") tape available
IAEA-NDS-86
INDC(AUS)-12 (1987)

(3) ECPL-86, Livermore, 14 target isotopes from 1-H-1 to 8-O-16 IAEA-NDS-56 in ENDL Transmittal Format (IAEA-NDS-53).

A more recent version of this library could be requested from Livermore. The problem is the format. A code for producing ENDF-6 format from Livermore internal format should be available; but the conversion is not fully automatic and presents a manpower problem.

(4) Calculated data for selected reactions induced by p, d, and α for nuclides Z = 21 to 83 from report NNDC-1975 in a format similar to ENDF. IAEA-NDS-59.

(5) Charged-particle activation data

See IAEA handbook 1987 part 3 (i.e., p. 441-630). Data not on tape.

Experimental Data

EXFOR:
Contains now quite a number of integral CPND, but completeness has not been analyzed. Only few differential data. Includes old McGowan file. Index to EXFOR CPND available on request.

Specific retrievals available on request, from which graphical plots can be made. ("Computational Format").

Bibliography for integral CPND has been published regularly by NNDC, but is now discontinued.

WORKING GROUP IV REPORT:

COVARIANCES AND SENSITIVITY WORKING GROUP

(Chairman: D.W. Muir)

This short working group session began with a review of the covariance files presently contained in ENDF/B-VI materials, and the plans for future inclusion of such files in others. A large percentage of the existing ENDF/B files do contain covariances. In addition, covariances for the standards materials will be completed by July 1990. Covariance files will be added to the evaluations for ^{14}N and ^{16}O, and perhaps to others (such as ^{nat}W) at the time of a future revision, which will not be earlier than late 1990. Such files appear to be sufficient to initiate the processing activity after 1990, although it was noted that there are no plans to evaluate covariances for the important nucleus ^{9}Be.

A question was raised concerning ITER requirements in this field. The sense of the discussion was that multigroup covariances would be welcomed and timely if produced by the end of 1991. The Agency's assistance was requested in inquiring from the ITER project which sensitivity will be used by ITER analysis system. Dr. Cheng agreed to inquire within the U.S. whether the two-dimensional U.S.-Swiss system SENSIBL could be internationally released. This system is directly compatible with the covariance output format of NJOY.

Covariance processing issues were also discussed. The most urgent need identified in this area is to add an LB=8 capability to NJOY, hopefully within the next few months. With respect to needs for code updates on a longer time scale (2-3 years), D. Larson expressed the view that adding an MF=30 capability to NJOY would have the beneficial effect of stimulating the use by evaluators of this new formatting tool.

IAEA Consultants' Meeting on

"First Results of FENDL-1 Testing and Start of FENDL-2"

June 25-28, 1990, IAEA Headquarters, Vienna
Meeting Room C-07/IV

LIST OF PARTICIPANTS

AUSTRIA

Prof. Dr. M. Heindler	Institute for Theoretical Physics Technical University of Graz Petersgasse 16 A-8010 Graz
Prof. Dr. H.K. Vonach	Institut für Radiumforschung und Kernphysik Boltzmanngasse 3 A-1090 Vienna

CHINA, P.R. of

Dr. Zhou Delin	Chinese Nuclear Data Centre (CNDC) Institute of Atomic Energy P.O. Box 275 (41) Beijing

CZECHOSLOVAKIA

Dr. E. Beták	Fyzikálny Ustav Slovenskej Akadémie Vied Institute of Physics Slovak Academy of Sciences Dúbravská Cesta 9 CS-842 28 Bratislava

GERMAN DEM. REP.

Prof. Dr. D. Seeliger	Sektion Physik Technische Universität Dresden Mommsenstrasse 13 DDR-8027 Dresden

ITALY

Dr. G.C. Panini	Centro di Calcolo del E.N.E.A. Via Mazzini 2 I-40138 Bologna

JAPAN

Dr. Yutaka Nakajima
Nuclear Data Centre
Department of Physics
Japan Atomic Energy
Research Institute
Tokai-mura
Ibaraki-ken 319-11

Dr. N. Yamamuro
Data Engineering Inc.
60 Kitahassaku
Midori-ku
Yokohama 226

NETHERLANDS

Dr. J. Kopecky
Department of Physics
Netherlands Energy Research
Foundation (ECN)
3 Westerduinweg
P.O. Box 1
NL-1755 ZG Petten

ROMANIA

Dr. V. Avrigeanu
Institute of Atomic Physics
P.O. Box MG-6
R-76900 Bucharest-Magurele

U.S.S.R.

Dr. A.A. Filatenkov
Radievyj Institut V.G. Khlopina
Ul. Rentgena 1
SU-Leningrad, 197022

Dr. A.V. Ignatyuk
Fiziko-Energeticheskij Institut
Ploshchad Bondarenko
SU-249 020 Obninsk, Kaluga Region

Dr. D.V. Markovsky
Institut Atomnoi Energii
I.V. Kurchatova
Ploshchad I.V. Kurchatova
SU-Moscow D-182, 123182

Dr. V.G. Pronyaev
Centr po Jadernym Dannym
Fiziko-Energeticheskij Institut
Ploshchad Bondarenko
SU-249 020 Obninsk, Kaluga Region

UNITED KINGDOM

Dr. R.A. Forrest
Nuclear Physics and Instrumentation Division
Building 418
Harwell Laboratory
Didcot
Oxon OX11 ORA

U.S.A.

Dr. E.T. Cheng
GA Technologies Inc.
P.O. Box 85608
San Diego, California 92138

Dr. D.C. Larson
Eng. Physics and Math. Division
Bldg. 6010, MS-356
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831

Dr. F.M. Mann
L7-29
Hanford Engineering Development Laboratory
Westinghouse Hanford
P.O. Box 1970
Richland, WA 99352

Dr. Phillip G. Young
Theoretical Division
T-2 MS-B243
Los Alamos National Laboratory
P.O. Box 1663
Los Alamos, NM 87545

IAEA

V.A. Konshin

J.J. Schmidt

D.W. Muir

A.B. Pashchenko

S. Ganesan

H.D. Lemmel

J. Martinez Rico

V. Osorio Fernandez

O. Schwerer

Wang DaHai

Fusion-related nuclear data needs and required activities after the completion of FENDL-2 (scheduled for the end of 1992)

1. Nuclear data needs after FENDL-2

H. Vonach, IRK, Vienna, Austria

Even after completion of FENDL-2 there will be a strong need for continuing evaluation efforts in the field of nuclear data for fusion for the following reasons:

(1) Given the presently available manpower it seems unlikely that even the presently known problems in FENDL-1 can be solved by FENDL-2. For example no commitment has been made as yet to the production of the urgently needed covariance file for ^{9}Be.

(2) In the course of the actual use of FENDL and its associated uncertainty files, especially in neutron transport calculations, it will certainly turn out that more accurate data will be needed for specific materials and cross sections and additional specific evaluation work will be needed to meet these user demands.

(3) If decisions are taken towards construction of neutron sources for materials testing using either spallation neutrons or neutrons from d-Li reactions there will be a strong demand for neutron cross sections above 14 MeV.

2. Future of FENDL

E.T. Cheng, General Atomic, San Diego, USA

(1) Revised or new evaluations will be needed beyond 1992 when better or more engineering-oriented neutron integral experiments will become available along with the progress of fusion energy development.

(2) A fusion material irradiation test (FMIT) facility will be needed as an important element of fusion reactor engineering development. For the construction of the FMIT, cross section evaluations for FMIT relevant materials up to 50 MeV will be required.

(3) Integral data testing experiments for both general purpose and activation libraries will be required from now on, and beyond 1992.

I would recommend that a CRP be formed coordinating the data testing activities for the activation cross section data library - maybe after I have conducted some investigations in this area - involving both 14-MeV-neutron generating accelerators and high-flux-thermal and fast reactors.

3. Need for FENDL-2 benchmark testing

A. Ignatyuk, FEI Obninsk, USSR

The FENDL-2 library, it seems, will be good for ITER only at the initial stage of this project. Existing fusion benchmarks provide tests of only limited numbers and types of nuclear data.

All the experience gained in thermal and fast reactor projects shows that only after accumulation of a large number of different types of benchmarks is it possible to obtain an overall testing of the recommended data and a realistic estimation of their uncertainties.

4. Activation libraries and general purpose files - activities after FENDL-2

Robin Forrest, AERE Harwell, UK and
J. Kopecky, ECN Petten, Netherlands

A. Activation libraries

(1) If it is found that sequential charged particle reactions are important (also γ-induced reactions) then the compilation of (α,n), (p,n), (γ,n), etc., libraries for a large number of targets will be necessary.

(2) The present activation libraries contain no uncertainty information. It will be necessary to include error data (but not covariances) for each of the 10 000 reactions in the activation library so that estimates of the error in the number of atoms in the calculated inventories can be made.

(3) The activation library in FENDL-2 will not have been tested in any integral way. It will be necessary to carry out measurements in a suitable spectrum to test the adequacy of the activation library. Updating in response to these measurements will be vital.

(4) A full decay data library is required for activation calculations. The adequacy of some of the data (e.g., half-lives) of some long lived nuclides such as ^{108m}Ag is not well known and may require more work. Remember that the present decay data libraries concentrate on nuclides important for fission.

(5) At present there are no data on actinides in the activation libraries. There are two reasons to include them:

   (i) U and Th occur as impurities in the materials that will be used for fusion reactors.

   (ii) People may wish to study fission/fusion hybrid reactors.

B. General purpose files

(1) The reason for production of covariance files is to do sensitivity calculations. Only once these have been done will it be obvious where the present evaluations need improvement.

(2) The restriction of nuclear data to less than 20 MeV will not be possible if reactor systems other than D-T magnetic confined fusion are to be designed.